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"FOREST-SUCCESSION AND ECOLOGY IN THE KNYSNA REGION"

(with 30 diagrams and 82 photographs, being the thesis submitted in partial fulfilment of regulations governing the degree of D.Sc. in the University of Edinburgh, 1927).

— BY —

JOHN F. V. PHILLIPS, D.Sc. (Edin.), F.R.S.E., F.L.S.
Formerly in Charge Forest Research Station, Deepwalls, Knysna, South Africa

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UNION OF SOUTH AFRICA.

DEPARTMENT OF AGRICULTURE, DIVISION OF PLANT INDUSTRY.

590, Vermeulen Street, Pretoria,

27th February, 1930.

Sir,

Mr. C. E. Legat, the Chief Conservator of Forests, has submitted to me the manuscript of a paper by Dr. John F. V. Phillips, formerly of the Forest Department and entitled "Forest Succession and Ecology in the Knysna Region." In doing so Mr. Legat has suggested that since the work is mainly of a botanical character I might consider it for publication as a Memoir of the Botanical Survey of South Africa, and he has indicated that if this were considered possible he would be prepared to contribute towards the cost of printing the same.

The work is a masterpiece of ecological and forest research in South Africa, and should serve as a model for future research which young South Africans might well follow. The treatise is of such an important, useful and highly instructive nature that it should most certainly be printed by the Department which has enabled Dr. Phillips to carry out this work.

I therefore beg to recommend that you authorize the publication of this work as Memoir No. 14 of the Botanical Survey of South Africa.

I have the honour to be, Sir,

Your obedient servant,

I. B. POLE EVANS,

Director, Botanical Survey of South Africa.

The Secretary for Agriculture,
Pretoria.

"FOREST-SUCCESSION AND ECOLOGY IN THE KNYSNA REGION."

INTRODUCTION.

Apart from the data obtained by Bews in Natal, very little is known concerning the ecology of the forests of South Africa.

In view of the fact that the country has been inhabited by the European for a comparatively short period and possesses limited indigenous forests (less than 0·3 per cent. of the total area of the Union of South Africa is forest-clad), this lack of knowledge is to be expected.

The present preliminary paper is one of the results yielded by a systematic study of the ecology and sylviculture of the forests of the Knysna Region since October, 1922—under the direction of the Chief Conservator of Forests for the Union of South Africa. The principal objects stimulating the study are as follows :—

(1) The obtaining of data relating to the *setting*, *nature*, and *development* of the Forests.
(2) The working out in detail of the life-histories of the more important species of trees and shrubs of the Forest-flora.
(3) The application of all relevant information obtained, to practical sylvicultural problems requiring solution.

The present paper is confined in its objects to a preliminary description of the general setting, nature, and development of the Forests of the Knysna Region.

From the outset the concept that the true foundation of a study with such widely-divergent aims must be quantitative data yielded by definite experimentation, supported by systematic observation, has been held by the writer. By observational (inference and sequence) studies, the quadrat-method, and instrumentation where necessary, the successional features and habitat factor have been elucidated to some extent. Intensive experiments carried out under *controlled* and under purely *natural* conditions alike, have led far toward a better understanding of the life-histories of the principal species ; extensive field experiments checked wherever possible by smaller intensive experiments, have been productive of the most valuable results. More recently the promising method of Phytometry has been employed in comparative studies of forest-habitats, with encouraging results.

The writer is desirous of acknowledging the long-continued assistance, through the media of numerous letters and valuable books, of Dr. Frederic Clements of the United States. Thanks are due to the following scientific workers for their invaluable advice and assistance from time to time :—

Professors Adamson, Bews, Schönland, W. Wright-Smith, and Doctors Doidge, Pole-Evans, and W. G. Smith.

Opportunity is likewise taken of expressing appreciation of the kindness shown at all times by the Chief Conservator of Forests, C. E. Legat, Esq., the Chief Research Officer, C. C. Robertson, Esq., the Research Officers of the Forest Department Head Office, Pretoria, the Conservator of Forests, Knysna, Richard Burton, Esq., and by the several District Forest Officers (Messrs. D. R. MacArthur and F. S. Laughton more particularly) of the Midland Forest Conservancy.

Throughout the period of study, able assistance with the reading of instruments and with clerical work has been rendered by the writer's father, J. R. Phillips, Esq.

JOHN PHILLIPS,
Forest Research Station,
Deepwalls, Knysna, South Africa,
22nd October, 1926.

Chapter I.

GEOLOGY, TOPOGRAPHY, SOILS.

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GEOLOGY, TOPOGRAPHY, SOILS.

Situated between 22 deg. 20 min, and 24 deg. 40 min. E. Long., slightly north and south of the 34th parallel, S. lat., bounded on the south by the Indian Ocean, barred from the interior northward by the Outeniqua and Zitzikamma Mountains, is the 5–30-mile wide plateaued coast belt of the districts of George, Knysna, Uniondale, and Humansdorp. Within this region lie macchia, forest, and scrub—the macchia being usually taller and more luxuriant than that at the Cape Peninsula, the forests, the largest in South Africa, the scrub, on the whole, less xerophytic than that of the Karroo and the Eastern Province.

Originating in far-off Bushmanland, continuing southward and successively known as the Bokkeveld, Cedarberg, Langberg, Outeniqua, and Zitzikamma Ranges, the mountain barrier north of this territory, since Jurassic times at least, has exerted a potent influence on the physiography, climate, and vegetation of the narrow strip of land it guards. The Outeniqua–Zitzikamma–Karedouw Ranges—the local names given the barrier as it passes from west to east—rise, at times from buttressing foothills of considerable size, at times abruptly from hills scarcely higher than the mean level of the plateau on which they seem to rest, to elevations of 4,000–5,000 feet, the Everest of the region being Peak Formosa (or Krakeel River), of 5,497 feet. From the foothills, smaller or greater, rise the vast lateral spurs—at times 500–2,000 feet above the deep, tortuous kloofs separating them—that form the body of the ranges, serving as massive foundations for the oft-times precipitous, krantz-faced, rocky spine—itself 500–1,000 feet high—at the summit. On the higher portions of the barrier-range the angles of declination are frequently 70–90 degrees. While these diminish considerably as the lower levels are reached, it is not uncommon to find extremely high angles of slope even at elevat ons of 2,000 to 3,000 feet.

Attending to the coast-belt itself, this is found to be made up of a series of plateaux, commencing 600 feet or more beneath the waters of the Indian Ocean, and rising gradually as it proceeds inland. Of these plateaux three only, demand description.

Lying submerged about 600 feet, and extending a number of miles out to sea, is the first plateau, the edge of which is famed as the *Agulhas Bank*. From the shoreward margin of this, the second plateau rises, for the most part abruptly, as a cliff-faced terrace, from out the boiling surf; it assumes a height of from 500–700 feet near the sea. (Between the Kaaiman's River and Gerecke Point, west of Knysna, the ever-blowing sea breezes have been responsible for the building up, during recent times, of a vast bank of dune-sand, several hundred feet in height. This wind-deposited barrier separates the sea from the George and Knysna lakes, which lie between the 700 foot plateau and the coast, in this particular region.) Extending 3–10 miles inland, intersected and re-intersected by deeply eroded river, stream, and kloof beds, this plateau varies from 500–1,000 feet elevation. This is known as the *Uplands Plateau*. It gradually assists in building up the foundations of the next, or *De Vlugt* plateau, to which it finally gives place on the north.

The *De Vlugt Plateau*, lying at 1,200–1,800 feet, in turn proceeds inland until it reaches the foothills or relatively low-lying lateral spurs of the barrier-range. Everywhere it shows deeply trenched, highly graded, narrow and tortuous valleys separated by row upon row of rounded-off ridges, all cut down to a comparatively common level. East of the Keurbooms River this plateau gradually disappears.

The major streams proceeding from west to east are the Brak, Zwart, Knysna, Keurbooms, Groot, and Storms Rivers. These have worn sinuous, steep, narrow gorges in the two plateaux, in instances several hundreds of feet deep: evidences of a young topography.

Occasionally, wider valleys with far less steeply inclined slopes are found where the softer Bokkeveld and Enon Beds have been extensively eroded by the rivers. The rivers are shallow except at their estuaries, are torrential, and quite unfitted for navigation except of the very meanest kind, and that for a few miles only.

The estuaries have been cut through the edge of the 700 feet plateau, and in instances these are flanked by dunes of aeolian drift. There are indications of drowning of the river mouths through *subsidence*, this process being complimentary, but subordinate, to that of *elevation* supposed to have been at work during the ages of geological time.

The occurrence of the barrier and of the three plateaux, and the indications of subsidence, are of more than passing interest, as reference to Schwarz's report on the geology of the region shows (Schwarz: 1905; 80–83). Briefly, Schwarz considers it probable that a see-saw motion in the rising and sinking of the land took place, the former being the more considerable. He concludes that the plateaux are *plains of marine denudation*, the points in favour of this being the occurrence of clays, sands, and gravels on the plateaux, and that the extreme narrowness of the plateaux would prevent the exceedingly short, highly graded rivers from acting upon the land so as to form *peneplains or base-levels of river erosion*. Rogers and Du Toit (1909: 383), however, dissent from Schwarz concerning this explanation of origin of these and of similar plateaux covered with gravels, both within and exterior to the Cedarberg–Langbergen Ranges. Indeed, they take the very view Schwarz rejects: *The plateaux are plains of river erosion, and their dissection is due to their being subsequently elevated and to the down-sawing action of the rivers.* They state that the concept of plains of marine denudation is inadequate to explain why marine shells should be absent from so large an area in the Knysna region westwards, while in the raised beaches in the Uitenhage district they should be so well preserved.

After very careful observations throughout the greater portion of the region, the present writer inclines to the view that *the plateaux have truly been formed through lateral planation by rivers and streams, considerably assisted by gradual elevation of the land-surfaces above the sea.* It is evident that at one time the height of the land above the sea was considerably less than it now is. The rivers flowing from the mountain-barrier seaward, at first would probably erode the plateaux in a general north to south direction; at the outset they probably were fairly straight, but later would develop bends, numerous tributaries, and innumerable subtributaries. The chief gradational forces must have been directed in downward directions and not in lateral ones—until such time as either more durable strata were met, or until the general level of the base of the river system had been eroded to a depth not much above the level of the sea, or possibly until a phase of subsidence of the coastal plateau came into action. The second and third possible causes of the down-acting processes being held in check are the more likely. Assuming that one or other of these two did take place, it is evident that the gradient of the rivers would become decreased to an appreciable extent, the result being the increased development of the tributaries and subtributaries.

Now this development of these smaller water courses would set up lateral erosion, the intervening smaller plains or ridges being gradually planed away until the main plateaux were worn down to approximately general levels—*base-levels of river erosion.* A further elevation of the land would re-initiate the cycle of gradation by increasing the gradients of the main waterways relative to the ocean. Thus the complementary processes of *elevation* and *subsidence*, and of *erosion* and *deposit* probably have been the grand factors in the formation and sculpturing of the high-level plateaux.

Judging from the *ligniferous sands of the Knysna Series*—described briefly in a later paragraph—lying in large basins in the *De Vlugt Plateau* and in smaller ones in the *Uplands Plateau*, the plateaux have been above the sea since Tertiary Times (late).

The barrier-range north of the plateaux was probably formed during the long interval between the late Palaeozoic and the early Cretaceous—perhaps during the Jurassic. Great thrusting from the south probably was responsible for these foldings; denudation must have been at its maximum for a lengthy period following the foldings, for it is likely that the mountains rose to greater heights then, than they do to-day. The material probably went to form the Uitenhage beds of the region, most of which have now, of course, disappeared.

The formations occurring in the region are as follows :—*

System.	Series.	Characteristics and Localities.
Pre-Cape.......... (Archaic)	Granite bosses.......	There are two well-defined granitic bosses in the George District, the larger is about 30 miles long and 4–10 miles wide, the smaller being about 10 miles long and 2–4 miles wide. They consist of a white muscovite granite, with occasional black biotite; they are not solid, but much crushed, creviced, and injected. They are clad in dense Macchia and Forest, and with their termination in the George District, there is an accompanying change in the strike of the barrier range, from east to slightly south of east. They are the last granitic bosses in the south of the African Continent.
Do............	Malmesbury.........	The larger granitic boss near George touches on the north, east, and south-east, the slates and quartzites of the Malmesbury Series, which bounds the smaller granitic boss on the west, south-west, and north. The slates have been penetrated by masses of granite, have been much sheared, and show in instances profuse development of mica; sheared phyllites and carbonaceous slates fairly rich in plumbago also occur. The extent of the series is less than that of the granite.
Cape.............. (Devonian)	Table Mountain Sandstone	Quartzites, sandstones, shales, forming the whole of the barrier-range and most of the plateaux; non-marine; probably a fluviatile deposit from shallow water on a slowly sinking area.
Do...........	Bokkeveld Beds.....	Quartzites, sandstones, shales, slates. These are infinitely softer beds than those of the Table Mountain sandstone, on which they lie conformably. They occur to-day as small inliers in synclinal valleys, the remnants of much larger portions let down among the harder beds of the Table Mountain sandstone by the great folding movements. They contain marine fossils—Orthoceras, Bellerophon, Spirifer, and others. The beds are far better represented than shown by Schwarz (1905), there being numerous small inliers in the Forests.
Cretaceous.........	Uitenhage (Enon Beds)	Conglomerates, sandstones, shales, with non-marine fossils; no definitely known plant remains have been found; pockets of poorly preserved lignite occur at the Bitou River. The nearby beds of Pisang River show more sand and clay, and finer conglomerates than those at Brenton (Knysna estuary) and at Bitou River. The mixture of pebbles, boulders, and fine material at Phantom Pass, may have occurred as the result of a mud-rush in Jurassic-Cretaceous Times.

* *Vide* maps of the region, for distribution of formations, partly original, mainly dapted from Schwarz (1905).

System.	Series.	Characteristics and Localities.
Cretaceous.........	Sunday River Beds...	Fossiliferous marine clays and limestones occur at Brenton in Knysna Estuary. Fossils found are Trigonia, Nautilus, and Ostrea. These beds are of very small extent.
Recent and Pleistocene	Knysna Series........	In the main forest near Knysna, at 1,000 to 1,300 feet elevation, there are deep hollows in the Table Mountain sandstone filled with sandy deposits bearing layers of semi-lignified and lignified coniferous stems, 6–10 inches in diameter and from several to over 20 feet in length; in addition there is true lignitic material in which the woody nature no longer appears. In all, the beds are over 200 feet deep, the lignified materials being in layers usually about 10 feet thick. They have been trenched to their base by local streams, showing that they must be of fair age. As the soft deposits would have been readily eroded on emergence, it seems clear they could not have been in position when last the plateau on which they rest was played upon by the ocean; moreover, there are no signs of a marine history. Probably they were laid down in fresh water when the land on which they lie was lower with reference to the ocean than it now is. Rogers (1909) has outlined the nature of the deposits; the present writer has worked on the lignified stems and found them to be of the same species throughout; a species of *Widdringtonia*. No other plant remains were found by the writer, but Rogers (loc. cit.) records some leaves which have been identified by J. F. Phillips, 1927 (3) as those of *Podocarpus elongata* L'Herit., *Gonioma Kamassi*. E. Mey., and possibly *Curtisia faginea* Ait.
Recent and Pleistocene	Alluvium............	Estuarine deposits below the surfaces of the various rivers, especially the Knysna, Noetzie, Bitou-Keurbooms rivers; also occur along the banks of these estuaries. The deposits are greenish sands and silts bearing marine shells belonging to extant species of the adjacent ocean.
Recent and Pleistocene	Ironstone-gravel, pea-ironstone, pseudo-lateritic nodules, or "ouklip"	Very abundantly developed at depths of 3 to 36 inches below the soil surface, especially in depressions. The deposits sometimes occur as sand-and-clay-free Limonite (hydrated sesquioxide of Iron), but more often as a sandy-ironstone not without superficial resemblance to a larva flow. The formation is brought about by the concentration of the Iron oxide near the surface of the subsoil, the poor drainage being responsible for its deposition from the watery solution of Iron, in excess of the original constituents of disintegration.
Recent and Pleistocene	Aeolian Drift.........	The sand is the result of long-continued breaking-up of shells and stones by the pounding action of the surf. The breakers toss up the sand, which is then borne inland by the sea winds. There are extensive dunes along the coast between Kaaimans River and Gerecke Point at Buffalo Bay, on Knysna Western Head at Groot River mouth, and along the Zitzikamma coast in various localities. They are usually Macchia, Scrub, or Bush clad several hundred yards from the sea. Some of the deposits between the Knysna Eastern Head and Harkerville, shown as Drift by Schwarz (1905; map attached thereto), to the writer appear to be portions of the Knysna Series.
Recent and Pleistocene	Raised Beaches.......	Some well-preserved raised beaches occur near the river estuaries, the shells being those of extant molluscs.

Influence of Geological Formation on Vegetation.

There seems to be a tendency on the part of ecologists to underrate the importance of the rôle played by geological formations in the development and moulding of vegetation. At the Knysna, however, some interesting features are revealed by a study of the vegetation as influenced by the geological formation on which it occurs:—

(1) Forest of climax nature occurs on all the beds above mentioned, excepting the Enon and Sunday River Beds, alluvium, and raised beaches, but the *type* of forest is influenced profoundly by the nature of the underlying rock when this is at no great distance below the level of the root systems of the trees. Macchia likewise shows variation according to nature of the substratum, but to a lesser degree than forest.

2. Apart from differences due to aspects, elevation, and purely local drainage and seepage, it is usually found that forest and macchia growing on soil overlying Table Mountain sandstone to less than about a dozen feet, are of *moister type*, of greater vigour, and better stocked with regeneration, than are those forest and macchia communities on Bokkeveld Beds. The Bokkeveld Forests have a dry appearance as regards the lower layers of woody shrubs and herbs; ferns are not nearly as plentiful nor as luxuriant as they are in forest on Table Mountain sandstone. The soil itself has a drier appearance than that of the latter type of forest, and on examination in the laboratory registers a lower average holard. The differences between the forests are attributable to the relatively rapid drainage of moisture through the porous Bokkeveld as compared with that through the Table Mountain sandstone, thus producing reduced holard especially in times of local drought. The slight chemical differences between the soils derived from the two formations are not considered sufficiently important to produce *type* differences; indeed, if anything, one would look for a better type of forest on the Bokkeveld-derived soils in virtue of their slightly richer supplies of salts. The pH values are usually higher, that is the soils are less acid, in the Bokkeveld Forests; at times they are even slightly alkaline (*vide* p. 30 for table of pH values).

3. On the Table Mountain sandstone different *types* of forest may occur: a very-well drained, dry to medium-moist *type*, and a decidedly badly drained, over-moist *type*. The dip of the beds has been found to be responsible for this *type* difference; horizontal, or nearly horizontal beds underlying the latter type, steeply dipping beds the former.

4. It has not been found possible to observe marked differences between the forests growing on Table Mountain sandstone and on the Malmesbury Beds. The fact that much of the vegetation on the latter formation has been considerably disturbed by exploitation, fire, and grazing for the past century, may be in part responsible for this, but even those few portions of undisturbed vegetation that still occur on the Malmesbury, show no marked differences from vegetation growing on Table Mountain sandstone.

5. As the Uitenhage Series in this region occurs practically at sea-level, or within a mile or two of the ocean, it is difficult to imagine what the influence of the formation itself, upon vegetation, would have been. Judging from the nature of the Alexandria Forests lying between Port Elizabeth and Port Alfred, and in parts five to ten miles from the ocean, the *type* would be intermediate in moisture relations—slightly moister than Bokkeveld Forests, slightly drier than Table Mountain sandstone. There are several isolated forest patches lying at 300–400 feet elevation, and fairly well sheltered from the sea breezes, near Knysna village; these are on the Uitenhage Beds.

Although these for over a century have been much interfered with, it is clear from observations made in them, that provided climatic factors are much the same, forest on Uitenhage Beds is of lower height-growth than forest on the formations already discussed, and in addition, exhibits a greater development of thorny species and lianes. These features are also shown at Alexandria.

6. The occurrence of pseudo-lateritic nodules at depths of from twelve to twenty-four inches results in the production of a drier, shorter *type* of forest on Table Mountain sandstone. In times of drought, the more moisture-requiring species show signs of discomfort. Macchia on such deposits (at times three to six inches only, below the soil surface) shows a decreased luxuriance. In moist weather the macchia soils become water-logged, and show high acidity (pH 4 to pH 4·5). The presence of high-lying, thick laterite has a profound influence on the class of tree plantation that can be grown on the site—poor, stunted trees usually being the product of such localities.

7. Aeolian Drift, as in the instance of the Uitenhage Beds, usually occurs so near the sea that its direct action on vegetation often cannot be separated from that of climatic factors. At Harkerville, however, at an elevation of from 600 to 800 feet, and at distances of from one to three miles from the sea, extensive development of old Aeolian Drift does occur—overlying the Table Mountain sandstone to a great depth. Here the influences of proximity to the sea can be slight. The forests are of excellent nature, but, on the whole, are slightly shorter than those on Table Mountain sandstone (excepting the *type* on shallow pseudo-laterite). The forests are also somewhat drier, and show greater development of thorny species.

8. The various species of the forest and macchia show preference for neither one formation nor another, occurring on all. Naturally, differences in density and luxuriance do exist, in accordance with what has been stated in the foregoing accounts.

Summing up, it is possible to state that while species may be found on all formations, while forest and macchia may occur on almost all, there are slight differences produced in the form and structure of these communities, as the result of geological formation, provided the soil does not cover the strata to too great a depth.

The subject of influence of geological formation and derivation on the nature of the soil is discussed in the next section.

Soils.

Past Work.

The physical, chemical, and biological nature of the soils of the region has received very little study. The reason for the small amount of attention paid to these subjects is that the country is for the most part a non-agricultural one, and until very recently, was not much utilized for the planting of exotic tree plantations. A careful investigation of the various soil factors and soil classes on those areas now being planted so extensively with exotic trees, is urgently required, if the best results are to be obtained.

Such work as has been done, is described, together with the writer's own observations, in the paragraphs to follow:—

Influence of Geological Formation and Derivation on Nature of the Soil.

At the Knysna, as everywhere else, soils lying *in situ* on their mother-rocks naturally are much more directly influenced by the chemical and physical properties of their parents, than are those soils that have been removed from their original sites and have been re-deposited elsewhere, after greater or less mixing with soils of other formations, or of similar formations in other localities. While undue emphasis has been laid upon the importance of geological origin by some students of soils, it is nevertheless perfectly true that in particular instances very definite differences are reflected in soils of different geological origin, differences that are strikingly borne out by the natural vegetation *types* on the soils concerned. Thus at the Knysna, the 700 feet and 1,200 to 1,800 feet plateaux are geologically young, much of the soil lies *in situ* on the parent rock, and has been fundamentally effected in nature by the latter. The reverse : that little difference is shown between soils of different origins, is also exemplified in parts of the region—the soils of the granitic bosses and of the Malmesbury Beds are physically, chemically, biologically as poor as are those of the adjacent Table Mountain sandstone, practically no differences being shown by the vegetation on the several formations.

Returning to the subject of the soils of the plateaux being influenced by the mother-rocks, we find that the Table Mountain sandstone yields a distinctly poor soil—fine-grained, close, cold clays near the mountains ; fine-grained clays richer in sand on the plateaux.

Chemically, they show poverty, the chief constituents, lime, potash, and phosphoric acid not reaching 0·1 per cent. of the weight of the fine earth, and very frequently being represented by such low figures as 0·02 per cent. lime, 0·01 per cent. potash, and 0·01 per cent. phosphoric acid. Juritz (1910 : 164), working with forty-six soils from the Table Mountain sandstone in various districts of the south-western region, gives the average percentage of the reserve plant food as lime 0·034 per cent., potash 0·031 per cent., phosphoric oxide 0·036 per cent.

The present writer has found the pH values, on the whole, to be low, ranging from pH 4 to pH 5·9 or 6.

The Bokkeveld Beds, occurring as inliers in synclinal valleys in the Table Mountain sandstone, show soils somewhat different from those of the latter formation with regard to physical and to chemical properties. Physically, the soils are much more porous, are better drained, and more friable. Chemically, they are much richer in lime, potash, and phosphoric oxide, containing as much as from 0·2 to 0·3 per cent. lime, 0·1 to 0·2 per cent. potash, and 0·1 to 0·15 per cent. phosphoric oxide. The pH values are high—pH 6·0 to pH 8 (*vide* page 30 for table of pH values).

Differences in vegetation *type* in communities on these and on Table Mountain sandstone soils have already been discussed.

Naturally, modifications are introduced by the advent of external factors ; thus the Table Mountain sandstone soils near the coast line are much improved by lime-containing aeolian sand, rendering the soils less compact and less acid.

Soils of the Uitenhage Series, too, are markedly different from those of the Precape rocks and the Table Mountain sandstone, but approach in chemical value those of the Bokkeveld Beds, being fairly well provided with lime, rather less so with potash, and slightly less so with phosphoric oxide. Their reaction is slightly less acid than that of the Bokkeveld. Physically, the soils are lighter, but more retentive of moisture than those of the latter beds. In places near the ocean they have been much altered through the incoming of aeolian drift, and in lower depressions, by the deposits of alluvium from the interior.

From the foregoing, it seems clear that the geological formation at the Knysna cannot be said to play a part entirely unimportant so far as nature of the soil is concerned. This is in part the reverse of the opinion of D. E. Hutchins (1893 : 128), who stated that the poverty of the " moorland soil " was independent of the geological formation, and was due to climatic conditions entirely. Without desiring to detract from the truth of his statement that the climatic factors do wield a powerful influence on soil nature within the region, it is suggested that a factor of such obvious importance as the geological origin should have received greater recognition.

Influence of Climatic Factors on the Nature of the Soil.

Hutchins (loc. cit.), as already mentioned, believed that the soils of the region were acid and unfertile owing to climatic factors. In this connection he considered the following conditions responsible for the poverty of the soils :—

(1) The leaching out of plant foods by the frequent rains, as fast as they are formed from organic matter and rock minerals.

(2) The absence of frost sufficiently severe to assist appreciably in the breaking down of the rocks.

Observations made by the present writer lead him to conclude that the leaching effects of the well-distributed and copious rainfall are without doubt far-reaching. Lysimetric measurements carried out at Deepwalls indicate that the upper layers, humus and soil proper to a depth of from 6 to 12 inches, yield 70–90 per cent. of their water content, in heavy rains, to the underlying soil and subsoil. This results in continuous leaching of salts from out these upper layers. The acidity gradients (*vide* p. 30 for table of pH values) so common in the soils of the region are to be accounted for not only by the greater amount of organic matter in the upper layers, but also by the removal of bases from these layers, and their deposition at lower ones. Actual loss of salts from the lower levels, too, takes place through lateral drainage, especially on steep slopes. The water of streams annually bears away some portion of the chemical foods washed from out the upper and lower soil layers. Organic matter as well as inorganic is removed to a considerable extent. Examination of the river water at almost any time of the year shows it to contain organic and inorganic acids ; even when flowing strongly, such water shows pH values ranging from 5·7 to 6·5.

The sequence of results following the occurrence of a heavy annual rainfall (*vide* Tables XX and XXII for rainfall data) and a base-deficient country rock is interesting : soil and vegetation are influenced, while domesticated animals and man also are affected. Domesticated animals, to ensure their successful rearing, require artificial supplies of bases, while the acid water used for drinking purposes by the indigent woodcutter (European) population seriously decays the teeth at an early age, and thus lowers the general vitality of persons of all ages.

Reverting to the leaching effects of the heavy rainfall, a most important result of leaching and re-deposition is seen in the formation of the extensive pseudo-lateritic nodules, or "ouklip," already described (*vide* p. 16). These semi- or totally-impermeable pans exert an influence on vegetation in some respects comparable with those of "*Ortstein*" in North Germany and elsewhere in Europe, as described by Graebner (1901) and others. The effects of this formation on vegetation at the Knysna has already been mentioned (*vide* p. 18). It remains to add that macchia often remains climax or sub-climax on areas where the layers are shallow and thick ; on such sites the formation of the deposits is still in active progress.

The slight influences of frost, too, are important both in natural and in worked soils. The clods of the plough "cake" hard on drying, as there is insufficient frost to break them down. So far as rock-decomposition is concerned, however, it is noteworthy that the roots of trees and macchia plants exert a strong influence in the direction of the making of new earth, and possibly compensate for the rarity of frost. Sandstone lying from 6 to 24 inches below the surface of the ground, in forests, in its upper portions is seen to be porous, friable, and readily breakable, whereas strata at slightly lower levels are absolutely impermeable. This gradual alteration of the rock must produce much new material for soil-formation.*

The Influence of Fire upon the Nature of the Soil.

Hutchins (1893: 128) draws attention to the evil influence on the soil of fires in the macchia, these fires sending seawards such plant-food as has been formed by the vegetation at the soil surface.

C. B. McNaughton, Conservator of Forests in this region from 1897 to 1908, in various Forest Department reports emphasizes the detrimental results following the continued burning of macchia soils. Bews (1918: 148) has touched upon the subject of soil-erosion in South Africa, resulting from firing of natural grassland, while E. P. Phillips (1920: i and ii) has carried out veld-burning experiments in grassland at Pretoria. The emphasis in Phillips's work has been more in the successional aspects involved, but the following conclusions were arrived at with respect to purely edaphic factors :—

(1) The temperature of soil covered by vegetation has a more even range than that of soil denuded; diurnal temperatures were much higher on the denuded than on the vegetation-clad sites.

(2) Denuded soil takes up more water after rain than does vegetation-clad, but evaporation is so severe that the water-content soon drops. Vegetation-clad soil shows less fluctuation in this respect.

Thomas Eden (1924) has contributed a thoughtful paper to the subject of edaphic factors accompanying the succession after burning. He carried out experiments on Harpenden Common, Hertfordshire, England, and so important is the bearing of some of his results that a discussion of certain of these at this juncture is justifiable.

The lime-requirement (Hutchinson and McLennan, 1915) is greater on burnt than on unburnt ground, and this difference is the more marked in the uppermost soil layers. The values given by Eden are :—

Nature.	Depth in Inches.		
	0–1.	1–4.	3–7.
Burnt soil	0·50	0·37	0·29
Unburnt	0·37	0·33	0·28

These differences decrease as the succession proceeds toward the climax. Several hypothetical explanations for the phenomenon are advanced, but Eden favours the view that burning increases the humic bodies, and thus increases the lime requirement. Increased humification occurs on burnt soil, and this difference between burnt and unburnt soils decreases as the succession proceeds.

The potash content is not increased by release of this salt from the ash of the vegetation. Destruction of vegetation reduces the moisture content of the soil in the first inch, but the lower levels are moister in burnt ground than in unburnt.

The determining factor, he concludes, is humic content, working, perhaps, through soil-acidity.

* *Vide* p. 206.

The subject has received a little attention from the writer, in connection with general succession studies. Soils in burnt macchia have been compared with those from macchia unburnt for five years, adjacent. The more important data so far obtained from experiments are :—

pH values for the upper 1 to 6 inches of soil (rich in humus) decrease after burning : that is, soil acidity increases, as shown in the table below :—

Nature.	Depth in Inches.	
	0–1.	4–6.
Burnt soil	5·0	5·5
Unburnt	5·6	5·6

As the succession progresses, the differences decrease and eventually disappear.

The surface-soil temperatures, as well as those temperatures recorded at a depth of 6 inches below the surface, are considerably higher in burnt soil than on unburnt. Temperatures of 150° F. to 170° F. are of frequent occurrence at the surface during warm periods throughout the year ; the subsoil (2 to 4 feet according to locality) temperatures show little increase—3 to 5 degrees F. greater than those recorded for the same depth under vegetation ; the temperatures at 6 inches below the surface, however, in newly-burnt soils are usually 10–20 degrees higher than those for soils under macchia.

The holard of burnt, fully-exposed soils is lower in the upper 6 inches than that of similar macchia- or forest-covered soils adjacent, but often the difference is in the reverse direction, at greater depths. When the ash lies *in situ*, it and the dry debris assist the upper soil in conserving the water of the lower layers, they being mulch-like in their action.

During windy weather, considerable loss of ash is caused, the soil being swept clean ; drying winds smooth and harden the surface. If heavy rain follows such winds, the baked surface absorbs little moisture, the run-off is great, the water speedily finding its way to streams. Northern, north-western, and north-eastern slopes suffer more in these respects than do those of southern nature.

Useful animals, such as earthworms, are killed in the upper layers, and do not reappear in large numbers for some years.

Humus content is lowered by burning ; a severe fire destroys almost every trace of humus and semi-humified litter.

The whole subject is a fascinating as well as an important one in forestry and agricultural economics. Wholesale burning of soil is carried out year after year ; the effects of such practice should receive careful scientific investigation, for the end results might prove detrimental to soil quality and productive capacity. In this connection see Phillips ; 1930 (2).

The Physical Properties of the Soils.

The physical properties of the Knysna soils have received practically no study apart from the observations of McNaughton (in various Forest Department records) and the recent investigations of the present writer.

McNaughton's observations may be summarized thus :—

The depth of the soil naturally varies much—from a few inches to several feet. The subsoil usually is a clay, either heavy and compacted, or else loose and friable. Finely-divided sand occurs in some localities, while in others are clay-slates, sandstone, and conglomerates. Patches of pea-ironstone, so common a feature of acid soils, are abundantly developed. From the timber-producing point of view, there is sufficient depth of soil and subsoil to carry the majority of timber species successfully.

The physical factors that have received attention from the writer are the *general physical composition* and the *moisture-contents*. A full discussion of these investigations here is not possible, by reason of space, and also because sufficient information on many important points is not yet available. A concise summary of the leading features so far noted alone is attempted.

General Physical Composition.

Following Hilgard (1912 : 84), Phillips has arrived at the percentages of plastic clay in the soils by placing the limits of this material at and below such grain sizes as will remain in suspension in an 8-inch high solution of distilled water for 24 hours. For all practical ecological and forestry purposes it seems that sufficient accuracy is obtained by this method. According to this method of clay separation, the soils of the region may be classified as follows :—

Class of Soil.	Percentage of Clay.
Dune sands	Less than ½ per cent.
Littoral Bush sands	3–5 per cent.
Sandy loams	10–15 per cent.
Clay loams	15–25 per cent.
Moderately heavy clay soils	25–40 per cent.
Heavy clay soils	40–50 per cent.

The heavy clay and the moderately heavy clay soils are best represented by the soils at fairly high altitudes, near the mountain slopes, and very often on these. These soils usually bear macchia, either as the climax or the subclimax vegetation. Examples occur on the plateaux as well, where macchia or poor class moist type forest prevails. The soils are stiff, compact, heavy, cold, and show high holard ; they are abundantly provided with raw acid humus to depths of from 2–6 inches, and on the less steep sites overlie sheet rock or later te at depths of from two to many feet. They exhibit high maximum water-retaining capacity (*vide* Hardy, 1923) and high echard (Clements, 1905).

The *clay loams* are representative of much of the soil of the plateaux ; these soils overlie heavy clay or laterite, or sheet rock ; they are less heavy, are warmer, and better drained than those of the preceding class.

They support taller macchia and the bulk of the high forest, and their humus contents are accordingly high.

The *sandy loams* are to be found on portions of the "*Uplands*" and "*De Vlugt*" plateaux, but are better represented on the first-named ; they owe their origin to the presence of the sandy beds of the Knysna Series and to aeolian drift ; some soils of the Enon Beds may be grouped here, while much of the best alluvium may also be included. These are lighter, warmer, more porous, and better suited to agricultural purposes than the soils of the clay loams class. In nature they bear high forest and macchia.

As would be expected, notable exceptions to the general zonation of the soil types are to be found, e.g., excellent, porous, deep soils occur far inland, along the valleys of Bokkeveld Beds.

Littoral bush sands occur near the seashore wherever the precipitous cliff-edge of the "*Uplands*" plateau has been broken away by erosion or earth movements ; the sands are derived from Table Mountain Sandstone covered to scores of feet in aeolian drift sand. The sand has become compacted with time, and has been appreciably improved by the addition of much inorganic and some organic matter from leaf-and-branch-fall, over many centuries; the humus content is from 3 to 6 per cent. (loss-on-ignition method)—considerably lower than that of the foregoing classes.

Such sands support subclimax or seral littoral scrub or littoral bush, and, in the more sheltered localities, littoral-type high forest. When worked, they provide fair agricultural lands, but on account of their sandy nature are apt to be blown in heavy winds.

The *dune sands*, resulting from the disintegration and pounding down of shells and rock by the breakers, are identical with those of similar origin in other regions of the world, except that they are somewhat poor in lime. They bear the pioneer stages of the Psammosere described on a later page (Chapter 4). In localities (Buffalo Bay and Knysna Western Head) they are encroaching on the soils inland; at Buffalo Bay the Forest Department is taking active steps to stem the advance.

Table I.

REPRESENTATIVE SOIL CORES FOR EACH SOIL CLASS, TAKEN BY MEANS OF GEOTOMES.

Depth * in Inches.	Heavy Clays. (1)	Moderately Heavy Clays. (2)	Clay Loams. (3)	Sandy Loams. (4)	Littoral Bush Sands. (5)
2–6	Raw, acid humus.	Humus acid, but less so than in (1)	Humus acid.	Medium - acid humus.	Dry very slightly acid humus.
6–18	Moist, black, heavy clay loam; very stiff.	Moist, black, or grey, heavy clay loam; opener than in (1)	Damp, grey clay loam; moderately porous and much lighter than (2) for working purposes.	Slightly damp, pale-brown to yellowish, porous sandy loam, readily worked.	Very pale, very light sand with slight admixture of sandy loam. Usually too light for working purposes.
18–48	Heavy red or yellow clay	Red or yellow clay, slightly less stiff than that of (1).	Coarse - grained clay, more permeable than that of (2).	Clay loam merging into coarse-grained clay.	Sandy, decreasing in humus and loam contents.
—	Sheet rock of impermeable nature.	Sheet rock of impermeable nature.	Sheet rock of impermeable nature.	Semi - porous sheet rock.	Hard and impermeable sheet rock.

* Depth below the surface of the soil. Examples are from typical cores for each soil class; modifications are introduced through occurrence of rock nearer the surface, or through differences in angle of dip of the rock, or through occurrence of lateritic deposits immediately below the surface.

Moisture Relations.

With a well-distributed, fairly heavy rainfall, and a humus-rich soil well covered with vegetation, it is not surprising to find the moisture content of the soils abundant. Drought periods, which are rare, very seldom succeed in reducing the holard of average soils to a point equivalent to or below the echard. Determinations of the holard at intervals of from two to seven days, at various stations in the forest, have been made since 1922. Determinations have also been made in macchia soils from time to time. A summary of the mean holard values for several of the stations follows:—

Table II. REPRESENTATIVE HOLARD VALUES FOR SEVERAL STATIONS.

Station.	Description of the Localities.	Soil Nature.	Holard: Mean % on dwt. at 6–9 inches.	Holard: Absolute Maximum.	Holard: Absolute Maximum.	Cores Taken.
	NOTE.—Stations Nos. 1, 2, 3, 4 are on the same hill, and at the same elevation (1,725 feet). Nos. 1 and 2 are on the northern aspect, 3 and 4 on the southern.					
1	Exploited Forest site, with vegetation entirely removed from soil; aspect north, slope 12 degrees; experiences severe insolation throughout the year; surface-soil temperatures and 6-inch-below-the-surface temperatures are given in Table VIII as well as temperatures 9 inches above the surface	Humus 2–3 inches; a grey clay loam over clay	33·0	54·32	15·48	At 6 p.m. twice per week for one year, 1923-24.
2	Under Forest canopy (70 feet), 20 yards from Station No. 1; high Forest of *Podocarpus Thunbergii-Olea laurifolia*, with abundant *Trichocladus crinitus* forming a 12-feet layer-society. Temperatures below and on soil surface, and above surface are given in Table VIII	Humus 2–3 inches; a grey clay loam over clay	46·0	84·50	23·73	At 6 p.m. twice per week for one year, 1923-24.
3	Exploited Forest site, with vegetation entirely removed from the ground; aspect south, slope 10 degrees; experiences severe insolation in summer months and during late August, September, April, and early May. Air temperatures in shade 5–10 degrees F. lower than those at Station No. 1; surface-soil temperatures 30–40 degrees F. lower; 6-inch-below-surface temperature 5–7 degrees F. lower	Humus 2–3 inches; a grey clay loam over clay	51·4	84·63	16·52	At 6 p.m. twice per week for one year, 1923-24.
4	Under Forest canopy (70 feet), 25 yards from Station No. 3; high Forest of same type as that at Station No. 2, but with frequent *Blechnum capense* and occasional relict *Hemitelia capensis*, and less *Trichocladus*. Air temperature in shade 2–3 degrees F. lower than at No. 2; surface-soil and 6-inch-below-surface temperatures are also several degrees lower than at the latter station	Humus 2–3 inches; a grey clay loam over clay	54·36	106·69	20·78	At 6 p.m. twice per week for one year, 1923–24.
5	Under the *Platylophus-Cunonia* associes. South aspect, 1,600 feet; dense layers of *Hemitelia capensis*. Temperature (air, in shade) 1–2 degrees F. lower than at Station No. 4. Light intensity, 1/800	Humus very abundant, and acid; clay loam, heavy, stiff, over heavy clay	172·85	222·0	118·0	At 6 p.m. twice per week for one year, 1923–24.
6	Under high Forest (70 feet); with dense layers of *Aspidium capense*	Mild humus, 3–4 inches; light clay loam over well-drained rubble	57·25	88·0	27·0	At 6 p.m. twice per week for one year, 1923-24.

The echard, or so-called " non-available water content of the soil," has been determined, employing the more important species of forest trees, in their seedling stages, and the principal types of forest soil. Without attempting to enter into a detailed account of the behaviour of the various species in the several soils, it will be as well to outline the principal indications so far obtained.

Briggs and Shantz (1912), in their pioneer, thorough, and most stimulating researches concerning the wilting coefficient for different species of plants in various soils, conclude that the differences exhibited by plants in respect of the wilting coefficient are much less than have been supposed, and are so insignificant as to be of little practical value so far as drought resistance is concerned.

Clements, Hedgcock, and others find that different species wilt at different echards in the same soil, while Bates and Zon (1922 : 79–80) certainly incline to this view, concluding that between species of trees adapted to fundamentally diverse habitats there may be, under certain conditions of wilting, radical differences in the wilting coefficients. The results obtained by Phillips at Deepwalls are in agreement with those who find that there are differences between certain species in one and the same soil. It is, for example, found that *Apodytes dimidiata*, *Ocotea bullata*, *Platylophus trifoliatus* seedlings will wilt in forest soil of clay loam nature at 17 to 20 per cent. echard (basis of dry-weight of ovened sample), whereas those of Curtisia, *Elaeodendron spp.*, *Olea laurifolia*, do not wilt until the percentage has fallen to 10 to 15 per cent. ; *Virgilia capensis* seedlings in the same soil may not wilt until the moisture is as low as 8 per cent.

The soils of heavy clay nature show echards considerably higher than those of the clay loam class, the values being between 30 and 40 per cent of the dry-weight of the ovened samples.

The Chemical Characteristics of the Soils.

The chemical characteristics of the soils of the region have not been investigated intensively, but this much is clear : they are exceptionally poor in chemical foods. The earliest record of investigations into the chemistry of the soils is that of D. E. Hutchins (1890 : 99), in his Annual Report as Conservator of Forests. In his report he refers to chemical analyses, by the Agricultural Department of the Cape of Good Hope, of soil and subsoil specimens obtained from macchia at Concordia. The method of analysis is not cited, but the findings were that the soil and subsoil alike were moderately rich in organic matter, but deficient in inorganic foods. Lime was present in exceedingly small amount, while phosphoric acid and potash, too, were very poorly represented.

No further work was done until 1900, when Juritz (1900) published the analyses of 19 soil samples taken from the Knysna district ; of these only 1 was a forest soil, the rest being macchia and agricultural soils.

The data for the 19 samples, together with the analyses of 29 samples from the George district, and 4 from that of Humansdorp, appeared in Juritz's " Study of the Agricultural soils of the Cape Colony," 1910.

None of the samples from the George and Humansdorp districts were from the forests. Without citing details, a summary of the results obtained by Juritz [employing the standard method of extraction with HCl (Juritz, 1910 : 13)] is of interest :—

(1) The soils of the region round George are generally lacking in all the important mineral plant-food ingredients ; while they are rich in nitrogenous matter, and contain fair proportions of potash in certain instances, their lime and phosphatic contents are exceedingly low. North of the Outeniqua range, in the valley of the Longkloof (Table

Mountain sandstone, with inliers of Bokkeveld), potash is more abundant, while lime is slightly better represented than elsewhere in the region.

(2) The soils of the Knysna region proper are in most parts as poor as those of George, and indeed show a decrease in potash and phosphoric oxide contents; the lime, however, very slightly increases in parts. The nitrogenous content is high.

(3) The alluvium soils round Plettenberg Bay are richer in lime than any other soils south of the mountains, while their phosphoric oxide and potash contents, too, are fair. Average values for the alluvium soils are given by Juritz (op. cit. 70) as nitrogenous matter, 0·242 per cent.; lime, 0·221 per cent.; potash, 0·067 per cent.; phosphoric oxide, 0·068 per cent.

(4) The soils of the Storms River region (Humansdorp district) were equally poor with those of George and Knysna.

(5) The single sample actually taken from the forest, at Millwood, Knysna District, showed much organic and nitrogenous matter, but a general deficiency in mineral foods. Juritz's figures (op. cit. 69) are as follows:—

Percentage of Field Sample Fine Earth.	Percentage of Soil Sifted through a 1 Millimetre Sieve.				Percentage of Soil Sifted through a 0·5 Millimetre Sieve.		
	H_2O.	Organic Matter.	Chlorine.	N.	Lime.	Potash.	Phos. Oxide.
95·6	3·84	12·21	0·0813	0·413	0·032	0·028	0·056

Shantz and Marbut (1923) have seriously criticised the methods employed by Juritz in his investigation of soils of South Africa, as being of little utility and as yielding data that have no very definite meaning or value. While there can be no doubt that intensive work based on more recent and efficient methods is earnestly required in the Knysna and other regions of South Africa, it is equally manifest that Juritz has cleared the field of many obstacles that would surely have hindered workers of the future.

Since Juritz's work, the field has been untouched except for occasional Departmental analyses made by Stead. Stead's results are essentially as those obtained by Juritz, and need not be discussed here.

Chemical data collected by the present writer have been confined to determinations of the total soluble salts readily available to plants in the soil solution, and to determinations of pH values and organic matter content.

Total Available Soluble Salts.

The total soluble salts readily available to plants has been found to vary from 50 to 300 parts per million of the soil weight, the soils in forest usually being considerably richer than those of either climax or seral macchia. F. H. King (1905) has discussed in an exhaustive manner the subject under consideration. Bates and Zon (1922: 131) state that solutes varying in amount from 20 to 1,500 parts per million of the soil weight are ordinarily found in such extracts; hence the Knysna soils, even at their best (300 parts per million), appear to be of marked poverty.

Hydrogen Ion Concentration of Soils of the Knysna Region.

The sour nature of the soils of the region has long been known to practical men, and, indeed, received description by the earliest travellers.

Apart from the employment of the ordinary Litmus paper method, no investigation of the acidity factor was carried out until the writer commenced the determination of pH values for various soil-types in 1923–24. Bews and Aitken (1922), however, contributed the pioneer paper on the subject of the measurement of pH values in South African soils, in relation to plant distribution and other ecological problems. As their results have a direct bearing on work carried out by the writer in the Knysna area, they deserve summarizing here :—

Low veld and high veld soils in Natal were investigated colorimetrically. Of these the high veld showed the greater acidity (pH 4·5–5·0) the low veld being *miniacid* only (pH 6–7·0). Forest soils on the high veld, however, showed lower acidity than did those of open country (pH 5·4–5·7). Again, at Maritzburg, the northern slope of a hill showed pH 5·5, the southern 6·4 ; the northern slope bore grassy tree veld, the southern pioneer forest stages.

The most important feature indicated was the apparent decrease of acidity as the succession proceeded towards forest.

The writer has used the double-wedge comparator colorimetric method of Edgar T. Wherry (1924), and has endeavoured to compare the values obtained therewith with the qualitative indications yielded by the Comber (1920) and Truog (1920) methods. As Marloth (1924) has already pointed out, the Comber method does not yield results in keeping with the pH values obtained by colorimetric (or potentiometric) methods ; on the other hand, Truog's method, when used with care, does supply qualitative data that are capable of being referred to quantitative data obtained by the colorimetric and electrical methods. The Truog method, on the suggestion of the writer, is being employed by several forest officers in the Knysna region, and with fairly consistent and satisfactory results.*

The colorimetric methods, of course, are not entirely satisfactory. Bews (unpublished report to the Botanical Survey of South Africa, June, 1925) refers to this subject. So far as the writer's experience goes, the Wherry method in its most recent form, when used with care, and with properly regulated soil moisture ratios, gives results moderately consistent.

Numerous determinations of pH values have been carried out in various classes of soils and in various plant communities. A set of values giving a general impression of the acidity of the soils of the region is presented in *Table III*, *page* 30.

The following tentative conclusions with respect to acidity phenomena, have been drawn :—

(1) Acidity is, on the whole, greater in macchia soils than in forest soils ; exceptions are found when the heavy clay soils or heavy clay loams from deep, damp, shaded forest ravines in the possession *Platylophus trifoliatus*, are compared with the better class soils of the macchia.

(2) With few exceptions there are well-defined " acidity gradients " in one and the same soil, the acidity decreasing as depth increases, to a limit of about 36 to 48 inches.

(3) Acidity—with exceptions produced by local habitat and community factors—decreases as the sea coast is approached ; the most acid conditions are found on the mountain summits, slopes, and foothills. Even far inland, however, acidity is less in Bokkeveld-derived soils, than it is in the surrounding soils of the Table Mountain sandstone.

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* 1926.

(4) Acidity is temporarily increased by the burning of macchia and forest (*vide* pages 14–15), but is decreased by slashing of macchia or exploitation of forest.

(5) Earth-worm numbers per acre are related to degree of acidity, the higher the acidity, the lower the number of these organ sms (*vide* Acanthodrilidae under " Soil Biota," page 33).

(6) Judging from the extensive development of pseudo-lateritic nodules or " ouklip " of from 6–12 inches thickness—the production of ages of deposition of hydrated oxides of iron—acid conditions must have prevailed in the region for a very lengthy period, probably since shortly after the formation of the plateaux themselves.

(7) Acidity is decreased appreciably by careful cultivation of the soil and by the addition of lime or other base-containing fertilizers.

Alkaline soils are represented by some neutral and circumneutral Bokkeveld and Enon soils, but alkalinity is rarely exhibited by the upper six inches, the organic matter tending to make the layer very slightly acid (pH 6·8 to 6·9). Soils showing alkalinity greater than pH 8 (specific alkalinity = 10, where pure distilled water = 1) are rarely met. The physical and chemical and productive properties of the alkaline soils are preferable to those of the acid soils of the rest of the region.

Brak soil is the other representative of alkaline soils in the region.

Table III.

No.	Position.	Formation.	Soil Characteristics.	Depth of Sample.	Vegetation.	Successional Condition.	Acidity Values.	
							pH.	Specific Acidity.
				Inches.				
1	Estuary of the Keurbooms River	Alluvium derived from Enon and Bokkeveld	Pale green, sandy loam, many feet deep	9–12	Salicornia natalensis–Chenolea diffusa	Seral	8·0	0·10
2	Estuary of the Knysna River	Alluvium derived from Enon and Table Mountain sandstone	Pale green, sandy loam, many feet deep	9–12	Salicornia natalensis–Chenolea diffusa	Seral	7·2	0·63
3	Uplands Plateau	Bokkeveld inlier in a synclinal valley; 600 feet elevation	Light sandy loam	9–12	Dry Forest: Podocarpus Thunbergii-Olea laurifolia type, with abundant Trichocladus	Climax	7·3	0·50
4	Noetzie River: Sea slopes of Uplands plateau, 200 yards from ocean	Old dune sand over Table Mountain sandstone; 20 feet elevation	Light littoral bushsand, with dry humus	9–12	Littoral Scrub: Celastraceae-Sideroxylon-Rhus, spp. are dominant	Seral	6·9	1·25
5	Noetzie River: Sea slopes of Uplands plateau, 400 yards from ocean	Old dune sand over Table Mountain sandstone; 30 feet elevation	Much as for 4, but firmer and with more organic matter	9–12	Littoral Bush; stunted Podocarpus-Olea laurifolia-Celestraceae	Seral or subclimax	6·5	3·15
6	Noetzie River: Sea slopes of Uplands plateau, about half-mile from ocean	Old dune sand over Table Mountain sandstone; 30 feet elevation	Slightly heavier and richer in organic matter than for 5	9–12	Littoral Forest; Podocarpus elongata consociation with Aspidium and Knowltonia	Climax	5·9	12·5
7	Uplands Plateau	Table Mountain sandstone; 800 feet elevation	Humus, 3 inches	1–2	Mixed High Forest; Podocarpus-Olea-Ocotea-Apodytes	Climax	5·0	63
	Uplands Plateau	Table Mountain sandstone; 800 feet elevation	Sandy loam	9–12	Mixed High Forest; Podocarpus-Olea-Ocotea-Apodytes	Climax	5·3	50
	Uplands Plateau	Table Mountain sandstone; 800 feet elevation	Clay	18–24	Mixed High Forest; Podocarpus-Olea-Ocotea-Apodytes	Climax	5·6	25

Table III.—(continued).

No.	Position.	Formation.	Soil Characteristics.	Depth of Sample.	Vegetation.	Successional Condition.	Acidity Values.	
							pH.	Specific Acidity.
				Inches.				
8	De Vlugt Plateau	Table Mountain sandstone; 1,400 feet elevation	Clay loam over heavy clay; rich in humus to 6 inches, lateritic pan at 36 inches	9–12	Berzelia-Metalasia-Cliffortia Erica; height 8–10 feet	Seral (5–10 years old)	4·8	160
9	De Vlugt Plateau	Table Mountain sandstone; 1,400 feet elevation	Clay loam over heavy clay; rich in humus to 6 inches, laterite at 18 inches	9–12	Bobartia spp. dominant	Seral	4·5	315
10	De Vlugt Plateau	Table Mountain sandstone; 1,400 feet elevation	Humus 2–4 inches	1–2	Mixed High Forest	Climax	5·0	100
	De Vlugt Plateau	Table Mountain sandstone; 1,400 feet elevation	Clay loam	9–12	Mixed High Forest	Climax	5·1	80
	De Vlugt Plateau	Table Mountain sandstone; 1,400 feet elevation	Clay	18–24	Mixed High Forest	Climax	5·4	40
11	De Vlugt Plateau, but in deep ravine	Table Mountain sandstone; 700 feet elevation	Humus, 4–6 inches	1–2	Platylophus consocies, with dense Hemitelia	Subclimax	4·4	400
	De Vlugt Plateau, but in deep ravine	Table Mountain sandstone; 700 feet elevation	Clay loam	9–12	Platylophus consocies with dense Hemitelia	Subclimax	4·9	125
	De Vlugt Plateau, but in deep ravine	Table Mountain sandstone; 700 feet elevation	Heavy clay	33–36	Platylophus consocies with dense Hemitelia	Subclimax	5·3	50
12	Mountain Base	Table Mountain sandstone; 2,000 feet elevation	Heavy, peaty clay over pan of laterite	9–12	Stunted Macchia; Restiaceae-Penaeaceae	Climax	4·3	500
13	Near Mountain Base	Table Mountain sandstone; 1,600 feet elevation	Clay loam over heavy clay	1–2	Macchia: Burnt soil Unburnt soil	Climax	4–7 4·8	200 160

There are three types of brak soil present :—

(1) The exceedingly brak sands and silts of the *Zwart Vlei* (George and Knysna lakes) *type*. This is brown to black, possesses little plant-food, and supports a scant vegetation of marsh forms. It is practically confined to the shores of the *Zwart Vlei* itself (vide Map No. 2).

(2) The better class brak sands and silts of the rest of the larger George and Knysna lakes. This class has been improved by the addition of calcareous dune sand blown in from the shore. Vegetation is luxuriant.

(3) The greenish brak sands of the Knysna, Bitou, and Groot River estuaries. This class is, in parts, hundreds of feet thick, and is the result of ages of accumulation of sediment in deep rock channels. This class bears a characteristic vegetation of halophilous plants, chief of which is Salicornia natalensis.

In all instances the brak is due to sodium chloride. In type (1) no calcareous matter is available for neutralizing or converting the salt. In type (2) calcium carbonate in the aeolian drift sand neutralizes the salt, while in type (3) the gypsum (calcium sulphate) of the Enon beds combines with common salt, forming the innocuous sodium sulphate (Na_2SO_4).

Organic Matter in the Soils.

The soils, owing to the rich development of vegetation throughout the region, are exceptionally rich in organic matter; indeed in many instances there is a superabundance.

Little work has been done in connection with the important subject of determination of organic matter in the Kynsna soils; Juritz (op. cit. 1910) gives the percentages of organic matter in terms of percentage of soil sifted through a one millimetre sieve, the amounts being arrived at by the " loss-on-ignition " method.

The writer since 1922 has carried out a large number of determinations, employing the same method. While it is realized that the method has shortcomings,* it is argued that the Grandeau (1877) method of determination of the " matiere noire," despite modifications by Hilgard (1906) and the work of Alway, Files, and Pinckney (1910), contains equal, if not greater, sources of error. Furthermore, as the nitrogenous matter in forest and macchia soils is known to be more than sufficient, there is little need to determine the amount of humified material proper, likely to serve as a nitrogen source; finally, the " loss-on-ignition " method gives the total organic matter present in the soil, and this has an obvious bearing on the water retentivity and aeration of soils. The carbonate content of the soils worked with is so extremely small, that practically no error is introduced by their breakdown on ignition.

The soils may be classified as follows, in terms of percentage of organic matter (in terms of oven dry weight of soil) :—

(1) Peaty soils of mountain summits, slopes, valleys, and certain foothills: *20–40 per cent.*

(2) Soils of moist high forest and of macchia, also alluvium soils: *12–20 per cent.*

(3) Soils of less moist high forest and macchia: *6–12 per cent.*

(4) Soils of littoral communities: *3–6 per cent.*

(5) Dune sands: less than *1 per cent.*

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* *Vide* Report, Sub-committee of the Agricultural Education Association: The Mechanical Analysis of Soils: *Jour. Agri. Sci.*, 16 (1): 128-129.

The subject of annual addition of leaf-litter to the soil is one of some importance, and concerning which there are few data apart from the observations of several of the older school of German foresters. The writer has collected the litter (leaves, twigs, flowers, fruits, bark, etc.) cast per annum by different associations of forest trees and shrubs, has air and oven-dried the material, and has then weighed it. The figures obtained are interesting :—

(1) The *Platylophus trifoliatus* consocies (*vide* Phillips, 1925 : i) in one year may cast litter (per square metre of the crown-influence-zone at the rate of 15–25 ounces.

(2) The *Podocarpus-Olea laurifolia* type, with dense *Trichocladus crinitus* layer-societies, may in one year cast material with a dry-weight of from 10–15 ounces per square metre.

Remembering that the overwhelming majority of the species and individuals of the forest are "*evergreens*," it is seen that the accumulation of litter really proceeds at a fairly high rate.

Although the forests are usually fairly moist, and although there are numerous ground organisms in the upper layers of the humus carpet, the cast foliage of most of the forest trees does not decompose rapidly, principally on account of its coriaceous and semi-sclerophyllous nature.

Soil Biota.

This field has scarcely been touched at the Knysna, in spite of its possible importance in forestry practice. All that can be done is to record the meagre information available :—

Bacteria.

The soils of forest and macchia are well populated with bacteria of the genera Bacillus, Micrococcus, Proteus, Cladothrix, Azobacter, and Clostridium ; the writer has not yet investigated the parts played by these.

An important species is *Pseudomonas radicicola* Beijk, which occurs not only in the nodules of the Leguminous species [notably *Virgilia capensis* (tree), Podalyria, Crotalaria, Aspalathus, Indigofera, Cyclopia species (shrubs)] but also in the root-nodules of *Podocarpus elongata* L'Herit. and *P. Thunbergii* Hook. The occurrence of the organism in the former podocarp is described by Spratt (1912) ; the writer in 1922 isolated the same organism from the nodules on *P. Thunbergii*. Hook.*

The part played by *Pseudomonas radicicola* in the fixation of atmospheric nitrogen is too well-known to be discussed here, but the results of several experiments carried out with the organism are of importance :—

[Nobbe and Hiltner (1899) were able to show experimentally that the cultivation of seedlings of Podocarpus was impossible in the absence of the so-called fungus which was thought to produce the nodules ; seedlings with nodules, however, were grown successfully for the space of five years in nitrogen-free, quartz sand.]

The writer germinated in carefully sterilized sand and loam, and in control soils, a large number of podocarpia of *P. elongata* and *P. Thunbergii*, and established the following points :—

(1) Pseudomonas radicicola, in nature, enters into symbiosis with the young plant immediately on germination of the podocarpium.

(2) Bacteria-free seedlings can be grown in sterile soil for the space of several weeks, but are weak, and finally succumb.

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* *December*, 1930 : Saxton (S. Afr. Journal of Science, XXVII : 323–25) states he was unable to detect bacteria in nodules of *P. Thunbergii* collected on Table Mountain, but that he found fungal hyphae : he considers Spratt might have obtained different results had she examined species from their original homes ; my findings, however, go to support Spratt's results.

Pseudomonas radicicola Beijk = *Rhizobium radicicola*.

(3) Such bacteria-free plants, when supplied with water containing even a portion of the bacterial-content of a single, small nodule, within a few days exhibit the presence of incipient nodules, and gradually are able to assert themselves.

It is clear that the presence of the correct strain of *P. radicicola* in the soil is an essential to the successful establishment of regeneration of both Podocarpus spp. Soils lacking in the strain are either entirely incapable of supporting the seedlings, or else do not produce good results in the latter.

No other species of tree or shrub (apart from the Leguminosae) exhibit symbiosis with bacteria.

Protozoa.

Fantham (1922) describes the Protozoan population of three soil samples from the George District. As his account is the only one relating to Protozoa in the Knysna region, a summary of it is given below :—

No.	Depth of Sample.	Soil.	Site.	Protozoa.
1	Inches. 0–5	Agricultural soil; light-brown and sandy	Gwaayang, 30 ins. rain per annum, elevation 600 ft.	*Rhizopoda.* Amoeba spp. (6). *Heliozoa.* Actinophrys sp. *Mastigophora.* 1 sp. of each of the following :— Peranema, Oikomonas, Bodo, Cercomonas, Entosiphon, Pleuromonas. *Infusoria.* Cyclidium sp.
2	0–8	Mountain soil, dark loamy	Pinus insignis plantation soil, Jonkersberg, George; 40 ins. per annum; elevation 1,200 ft. Pinus insignis is poor	*Rhizopoda.* Amoeba spp. (2); Difflugia sp Euglypha spp. (2). *Heliozoa.* Actinophrys sp. *Mastigophora.* 1 sp. of each of the following :— Oikomonas, Bodo, Euglena, Entosiphon. *Infusoria.* Amphileptus sp. Protozoa present in small numbers only.
3	0–8	Mountain soil, but from another site	Pinus insignis doing well	*Rhizopoda.* Amoeba spp. (2); Difflugia sp; Euglypha spp. (2). *Heliozoa.* Actinophrys sp. *Mastigophora.* 1 sp. of each of the following :— Peranema, Oikomonas, Bodo Cercomonas, Entosiphon, Euglena. *Infusoria.* 1 sp. each of the following :— Lacrymaria, Colpoda, Cyclidium, Paramoecium, Stylonychia, Vorticella. Protozoa present in larger numbers as regards genera and individuals.

Apart from stating that Protozoa are present in large numbers in forest soils, the present writer is unable to add to the above information concerning Protozoa in the region under study, but Prof. Fantham and the writer have taken up the study of the Protozoa in different soil types.*

† Since this was written Fantham and Robertson (1928 : 378) has described in some detail the Protozoa determined from soil samples submitted by Phillips from experimental sites and Natural Forest, at Deepwalls. Physical factor data and vegetation descriptions are given.

Earthworms.

These are the only other organisms of prime importance. The indigenous Acanthodrilidae are well represented, and the exotic *Lumbricus rubellus* and spp., and Allolobophora spp. are frequent. The indicator value of the earthworms has been referred to by J. F. Phillips (1924 : 283) in an earlier paper Heavy soils of low pH value (pH 4 to pH 4·9) support less than 10,000 earthworms per acre, to a depth of twelve inches, whereas lighter, better class soils, of pH 5 to pH 6 support from 20,000–40,000 per acre. Soils rich in earthworms are better drained, better aerated, more chemically active, and better suited to agricultural and forestry pursuits, than those showing relatively low numbers of these organisms. The work of Olof Arrhenius (1921) in Java and California, and notes by Edgar Wherry (1924), Barrington Moore (1922), and E. F. Phillips (1923), in connection with acidity-preferences of earth-worms are worthy of study. Apparently earth-worms at the Knysna are able to live under considerably more acid conditions (extreme of pH 4) than those in Java and America—Arrhenius gives the extreme as pH 6, Moore and E. F. Phillips state pH 5, and Wherry records pH 4·7.

Other Organisms.

The various insects domiciled in the soil—Forficulidae, Coleoptera more especially—have been little worked systematically. but so far as the writer has been able to observe,* play no very important part in the life of the soil complex.

* By means of quadrats in natural vegetation and sowings of seeds ; also by the study of decomposition of cast leaves and twigs on quadrats.

Chapter II.

CLIMATIC FACTORS AND ZOOBIOTIC ASSOCIATES.

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A.—Climatic Factors.

Temperature.

Temperature data for the region are sparse. Readings have been taken at George and Knysna Townships for a number of years, it is true, but the thermometers do not receive fair, natural conditions of exposure, and the readings have been spasmodically taken.

Temperature readings have been taken at Storms River also, but the thermometers have been mounted on a heat-absorbing, strongly radiating concrete foundation, while the readings taken have been non-critical in nature. The data for the three stations are not worthy of publication. Critical readings of properly exposed standard instruments have been taken at Belvidere (34·04° S. lat. by 23·0° E. long.), situated about ten feet above sea-level, and at Deepwalls Research Station (33·9° S. lat. by 23·16° E. long.), situated at an elevation of 1,725 feet, since 1922. In addition, reliable readings are available for one year for Kaffirkop, 1,180 feet, several miles south of Deepwalls, and for one year from Harkerville, situated on the Uplands Plateau, about 650 feet above sea-level (34·03° S. lat. by 23·12° E. long.).*

The temperature variations within the region are by no means great; indeed the temperature is to be considered as the most equable in Southern Africa. *Excessively high* temperatures never occur, while *high* temperatures are rarely experienced. This is clearly indicated by the available *Solar radiation* temperatures given in *Table IV*, as well as by the *shade* temperatures shown for Belvidere, Kaffirkop, Deepwalls, and Harkerville, in *Table V*.

At the same time, very low temperatures are of very rare occurrence, and when they do occur, are confined to low-lying sites (so-called "frost-holes") and to the higher altitudes. Snow falls but once or twice per year on the mountain-barrier, and at very long intervals on the foothills and upper plateau (vide *Table XXV*).

The reasons for the equable temperature conditions are to be found *firstly* in the geographical position of the area—its shores are influenced by both the cold Benguela and the warm Mozambique currents; and *secondly*, in the general cloudiness [vide *Tables XV* and *XVII* (*a*) and *XVII* (*b*)] and high humidity (vide *Table XIX*) which prevent excessive heating during the day and excessive loss by radiation at night.

The *mean* temperatures recorded for Belvidere and Deepwalls are lower than those recorded for centres east and west of the region under discussion, thus:—

Station.	Latitude S.	Longitude E.	Mean Temperature (4 ft. above ground).
Capetown (Observatory)	33·56	18·29	62·00
Mossel Bay	34·11	22·09	63·30
Port Elizabeth	33·58	25·37	64·00
East London	33·01	27·54	66·00
Belvidere	34·04	23·00	61·90
Deepwalls	33·90	23·16	59·30

* Position in 1926.

There is a slight decrease in *mean* temperature as the coast is left and the mountain-barrier approached—the littoral proper is 2–3 degrees warmer than the plateaux inland, and the latter $1\frac{1}{2}$–2 degrees warmer than the mountain slopes. Readings of temperature taken by means of portable field thermometer sets and compared with thermograms produced by recording thermometers at Deepwalls, show that from time to time the differences in temperature between the littoral and the plateaux may be as much as 10 degrees (warm, dry weather, or cold, windy weather). Further, during the occurrence of strong Foehn-like (" Berg ") winds blowing from the north or north-west (*vide* description of these winds, pp. 51–53, this Chapter), it has been shown that the mountain slopes and foothills experience temperatures from 2 to 10 degrees higher than the littoral.

There are marked temperature differences between northern and southern slopes and also between eastern and western ones. Not only are the *mean* temperatures higher on the northern and western slopes than they are on the southern and eastern, but the *absolute* and *mean* ranges are also wider. An example of temperature differences according to aspect, is given in *Table VII*. Standard, screened thermometers were installed at heights of six inches, twenty feet, and forty feet above ground-level*, on the northern and southern slopes (15 degrees) of the same hill, and at the same elevation above the sea.

The sites were of the same area, and were cleared portions of the forest. From a perusal of the data it is seen that the more severe conditions are experienced on the northern slope. With reference to the height above ground, it is seen that, as might have been expected from theoretical reasoning, there is a steady decrease in temperature as the soil is left.

The influences of forest canopy upon air and soil temperatures have received fairly thorough study at Deepwalls for a period of three and a half years. In *Table VIII* are given the air temperatures nine inches above the soil, on two adjacent sites identical in elevation and aspect, *the one under forest canopy, the other fully exposed to insolation*, through removal of the upper canopy and the lower layers of shrubs, ferns, and herbs. It is readily seen that while the *mean* and *absolute maxima* are considerably higher under full exposure than on the canopied site, the *mean* temperature under full exposure is consistently 3–5 degrees higher, and that there is slight difference between the *mean minima*. Slightly lower *absolute minima* are shown by the exposed site than by the canopied one.

The *absolute maxima* occuring on exposed sites, e.g., such temperatures as 110° F., 105·5° F., 103° F., are responsible for the death of numerous young plants of tree and shrub species.

When such temperatures are accompanied by low humidity (15—25 per cent. R.H.) and by strong wind, the wilting of fully exposed branchlets of pole and of adult trees is brought about. Flower buds and young fruits, too, are at times severely scorched.

The *absolute minima* on exposed sites, on the other hand, rarely have an influence detrimental to plants, unless the sites be markedly low-lying and thus be subject to frost.

The influence of forest canopy upon the temperature of the superficial layers of the coil is well brought out in *Table IX*, wherein two adjacent sites at the same elevation and on the same aspect, *the one under forest canopy, the other fully exposed to insolation*, are contrasted in terms of *mean* temperature, and *absolute maximum* temperatures, at depths of one-quarter and six inches. The thermometers at the quarter-inch depth were standard, cylindrical-bulbed instruments, the bulbs being encased with a thin layer of thick linseed oil (renewed several times per week) to insure successful adhesion of the soil

* *Vide* Plate 74.

particles: the rest of the tubes were protected from the sun by means of a raised, aerated wooden case. The bulbs were placed slightly below the rest of the tubes. The instruments used at the six-inch depth were standard, cylindrical thermometers, their bulbs deing encased in a second glass tube containing parawax, the object of this coating being to insulate the bulb against sudden fluctuation in temperature resultant on the thermometer being pulled up from the soil for reading. (The parawax enables the observer to study the thermometer scale for several minutes without fear of the mercury changing its position.) The thermometers were housed in wooden tubes sunk in the ground to the required depth.

From *Table IX* it appears that the *mean* temperature one quarter of an inch below the surface, at 1 p.m., is considerably higher on the exposed site than it is under canopy, while the *mean* temperature at 7 p.m. is slightly higher, the difference being more pronounced in the summer months. (An exception is noted in the instance of 7 p.m. mean, June, 1925, when the temperature under canopy was 0•8° F. higher than in the open.) It is superfluous to point out that the *absolute* maximum at 1 p.m., under full exposure, is appreciably higher than that under canopy. The *absolute maximum* at 7 p.m. is slightly higher under full exposure, the differences being more marked in the summer months.

The great decrease in temperature with increase in depth of five and a half inches, is noteworthy. At the same time, the *absolute maxima* six inches below the surface, under full exposure, are of some magnitude: 76·0° F., 77·75° F., 79·0° F., and 80·5° F. The *mean* temperature at 7 p.m. is slightly greater than that at 1 p.m., under full exposure and under canopy alike (with the exception of the records for January and February, under canopy). It is clearly shown, also, that the *absolute maxima* under full exposure, at 7 p.m., are greater than those at 1 p.m.; the same applies to most of the *absolute maxima* under canopy. The reason for this interesting occurrence seems clear; the heat absorbed by the superficial layers of the soil during the warmest hours of the day—usually between 12 noon and 4 p.m. in summer, and between 1 p.m. and 3 p.m. in winter—is slowly conducted downwards, naturally losing much of its intensity as it progresses from the surface. The heat intensity conducted to the depth of the six-inch thermometer is naturally less at 1 p.m. than that conducted by any hour later in the day, unless there be a sudden downpour of rain or unless a cold wind spring up. The temperature at the quarter-inch thermometer, on the other hand, is almost coincident with that of the air immediately above the surface—that is, a sudden fluctuation in air temperature is within several minutes reflected by the temperature at a quarter-inch below the surface. There is a definite lag of from one hour to several hours (seven at times), in the instance of the six-inch instrument, but the current air temperature has been noted to produce an effect upon this instrument before 8 p.m. of the same day. The subject of lag at greater depths is referred to further on in this Chapter (*vide* p. 43).

Of interest in connection with the subjects of canopy influence and of lag in superficial temperatures are the examples of bi-hourly records of soil temperature one quarter of an inch and six inches below the surface, with accompanying maximum, minimum, and mean air temperatures nine inches above the soil, given for *a fully exposed site* and for *one under canopy*, in *Table X*. Records for a typical summer day and for a typical winter one are selected. At the three levels the difference between exposed and canopied sites are more marked on the summer day than on the winter. While, generally speaking, the differences at one quarter of an inch below and at nine inches above the soil, are more marked during the warm portions of the day, the differences at the six-inch depth are greater during the later hours.

Tables XI and *XII* contain examples of temperature conditions at greater depths, both under high canopy and on an adjacent area experiencing the same aspect and at the same elevation, but fully exposed to insolation. The instruments used were standard soil thermometers, their bulbs encased in parawax, and their tubes rubber insulated; they were placed in standard metal tubes supplied by Negretti & Zambra. The data are of interest for their own sake, and because they are the first deeper soil temperature records obtained for a South African forest. The only other soil temperature data published in connection with South African forestry are those of Sim (1907: 36) taken at Fort Cunynghame under cover of oak, eucalypts, pines at depths of one foot respectively. Apart from minor seasonal irregularities the data in *Table X* indicate that under full exposure and under canopy alike in January, February, March, November and December there is a *slight decrease in temperature as depth increases*, whereas in April, May, June, July, August, September and October, there is a *slight increase in temperature as depth increases*. Furthermore, in January, February, March, April, September, October, November, and December, the temperatures at one foot and at two feet are *higher on the exposed site*, while in May, June, July and August, they are *slightly greater under canopy*.

Table XI giving examples of hourly readings of soil temperatures *under canopy* and *under full exposure*, for a typical summer day and a typical winter one, clearly shows that *on the summer day there is a decrease in temperature with increased depth*, and that *on the winter day, there is an increase*. It is seen, also, from the diurnal and nocturnal means, that the *mean temperatures at night* at one-foot and two-feet levels *are very slightly higher than those of the day*. Finally, it is to be noted that the *mean temperatures* (diurnal and nocturnal) *on the exposed site are slightly higher than those under canopy*, but that the summer day means are higher on the exposed site.

The *mean range* decreases with depth, thus, under canopy we find the *mean ranges* to be as follows:—

Depth.	Year.	Mean Maximum. F.	Mean Minimum. F.	Mean Range. F.
1 foot.....................	1923 1924 1925	60·44 (March) 60·21 (Feb.) 61·38 (Feb.)	51·55 (July) 51·05 (Aug.) 52·30 (July)	8·89 9·16 9·08
2 feet.....................	1923 1924 1925	59·91 (March) 59·63 (Feb.) 60·83 (March)	52·27 (Aug.) 52·24 (Aug.) 53·47 (July)	7·64 7·39 7·36
4 feet.....................	1923 1924 1925	59·21 (March) 59·04 (Feb.) 60·19 (March)	52·94 (Aug.) 53·02 (Sept.) 53·97 (Aug.)	6·27 6·02 6·22

On the exposed site the same principle applies, the mean ranges being wider:—

Depth.	Year.	Mean Maximum. F.	Mean Minimum. F.	Mean Range. F.
1 foot.....................	1923 1924 1925	62·98 (Dec.) 64·54 (Dec.) 65·00 (Jan.)	50·35 (Aug.) 47·91 (July) 50·31 (July)	12·63 16·63 14·69
2 feet.....................	1923 1924 1925	62·43 (Dec.) 64·09 (Jan.) 64·17 (Feb.)	51·43 (Aug.) 49·66 (July) 51·57 (July)	11·00 14·43 12·60

A feature of interest connected with the deeply placed thermometers under canopy is the *well defined lag of the soil temperatures behind the air maximum and minimum temperatures.* It has been observed repeatedly that: (*a*) the one-foot thermometer in the evening reflects, to some extent, any extreme shown by the air temperature of the same day, but at 8.30 the following morning does so more clearly; (*b*) the two-feet thermometer in the evening does not reflect any extreme shown by the air temperature of the day, but to some extent does so at 8.30 the next morning; at 1.30 p.m. of the day following the extreme shown by the air temperature, a more definite reflection is shown, and by 7 p.m. this has become clear—thus a lag of from twenty-four to thirty hours is the rule; (*c*) the four-feet thermometer shows a lag even more pronounced—varying from thirty-six to forty-eight hours.

The thermometers on the exposed site do not show such protracted lag, the periods for the one-foot and two-feet instruments being quite six to twelve hours less than for their fellows under canopy.

From other soil thermometer observations taken at Deepwalls and from phenological studies, it seems that apart from the severe temperatures of the superficial layers of exposed sites, soil temperature changes little influence plant life within the Knysna region. Extremes do not occur, and the summer and winter means differ but little. *The high temperatures of the surface soil of exposed sites, however, play a most important role in plant succession.* Seedlings of most tree and shrub species and of many undershrubs and herbs, are lesioned at the collars by the severe surface soil temperatures. The dryness of the soil and the low humidity of the air immediately above the soil assist the heated surface in burning constrictions at the seedling collars. The insolation lesion is identical in appearance with the work of Pestalozzia Hartigii, Tubeuf, ("Einschnürungskrankheit"), and in Europe, the United States of America, and South Africa has been confused with the latter at every turn. Toumey and Neethling (1923 and 1924) working at the University of Yale Forestry School, have gone carefully into the literature, and also have experimentally proved that the constrictions or "*lesions,*" are produced by high soil temperatures accompanied by low soil moisture content. The present writer, working with seedlings of various Knysna trees, in 1922–1923 independently, found that it was possible to lesion plants by exposing them to either natural or artificially produced insolation of relatively high intensity. The tree seedlings were found to vary in degree of resistance to lesion formation, in accordance with the list given below:—

Most resistant.........	[Do not lesion unless surface soil contains less than 3 per cent. (dry weight) moisture, and unless temperature exceeds 165° Fahr. for over half hour.]
	Virgilia capensis seedlings in all stages; seedlings of all other Forest trees when well-lignified and of more than ¼-inch diameter at the collar; especially large vigorous plants of *Podocarpus elongata L'Herit; Curtisia faginea; Cunonia capensis.*
Moderately resistant...	(Do not lesion unless surface soil contains less than 3 per cent. moisture, and unless temperature exceeds 160° Fahr. for over half hour.)
	All seedlings (except *Apodytes dimidiata, Podocarpus Thunbergii, Hook; P. elongata*, L' Herit) on becoming slightly lignified at the collar (3 to 6 months of age). Slightly lignified *Apodytes* is delicate, but slightly lignified *P. elongata* and *P. Thunbergii* are able to resist higher temperatures than other spp. of the same age.
Lesion readily.........	(If the soil moisture at the surface of the soil drop below 3 per cent. and the temperature be greater than 150° Fahr. for more than half hour.)
	All seedlings on first appearance from seed (except *Virgilia capensis*), but particularly *Platylophus trifoliatus, Cunonia capensis, Ekebergia capensis, Kiggelaria africana, Olea laurifolia, Faurea McNaughtonii, Apodytes dimidiata, Ocotea bullata, Elaeodendron croceum, Podocarpus* spp.

There is naturally much variation according to soil colour (dark soil heats up more readily than light coloured), soil texture, (closely packed, fine soil absorbs and retains more heat than coarse, open soil) soil moisture (the drier the soil the lower the temperature at which plants lesion), aspect (northern and north-western aspects are the most severe), and nature of the individual seedling. In nature, many thousands of young plants appearing on insolated sites in exploited or burnt forest, or along exposed portions of the margins, are killed by the high surface temperatures; the influence upon succession is thus a potent one.

It is of importance to note [vide *Tables IV, V, VII, VIII, and IX*; the temperature records, in italics, were obtained on "Bergwind" days] that the *absolute maximum* temperatures are usually coincident with the occurrence of the hot, dry Foehnlike, north or north-western winds known within the region as "Bergwinds."

While frosts are of relatively rare occurrence in all parts of the region except the lowest lying, its classification as *an area of no frosts* (*vide* Frost Maps: Drought Commission Report, 1923), is not strictly correct. Low-lying sites—river valleys, ravines, large and small depressions between the hills—certainly experience severe frosts between May and August of each year. In certain localities, the frost may remain in position until as late as mid-day, owing to its receiving a comparatively slight amount of direct sunlight. Very rarely highly situated, exposed sites in the midst of the forests experience frosts of mild nature. The general country-side, however, does not experience frost. Since January, 1923, frosts have been recorded at the Deepwalls Research Station, 1,725 feet, situate on a hill rising out of the main forest; the summit of the hill has been cleared of forest. Observations have also been made at Belvidere, ten feet above sea-level. The data are submitted in *Table VI*.

Severely frosted foliage of certain species, e.g., of Ocotea bullata, Apodytes dimidiata, Platylophus trifoliatus, Cunonia capensis—usually suffer, especially if direct sunlight reaches the crowns at an early hour of the morning. The likelihood of damage being done is much increased if a wind spring up. Insolation-protected foliage suffers little.

Light.

Sunshine observations and light-intensity measurements were commenced by the writer in January, 1923; apart from the data thus collected there are no records for the region.

For conveying an idea of the amount and nature of the daylight available within the region, the data given in *Tables XIII* (average possible number of hours direct sunlight, by weeks, Deepwalls), *XIV* (*a*) (actual hours of direct sunlight per mensem, Deepwalls), and *XIV* (*b*) (average number of hours actual direct sunlight, Deepwalls, per diem) are useful.

From *Table XIV* (*b*) it is seen that the ratio of *possible* hours of sunlight: *actual* hours of sunlight, for the year is as *100 : 59*.

In this connection, the data—comparison of duration of direct sunlight for several centres in South Africa and overseas—in *Table XV*, are of interest.

The ratio of *direct, diffused* light is approximately *4 : 1*, there being no practical change in the ratio with season (vide *Table XVI*).

The condition of the sky at Deepwalls, at the hours of 8 a.m., 1 p.m., and 7 p.m., has been recorded for three years; for sake of example, the monthly averages of cloudiness at these hours are given (*Table XVII*) for the year 1925. [(O indicates a cloudless sky, 1 a sky one-tenth clouded, 10 a fully clouded (ten parts out of ten) sky, and so on.] In *Table XVII* (*b*) the degree of cloudiness for several centres in Cape Province and for the coast-belt of Natal, is compared.

The light, in filtering through the various forest layers is naturally much decreased in intensity ere it reaches the forest floor. The values given in *Table XVIII* for this reduction in light-intensity, are representative of hundreds of measurements made per Clements's Stopwatch Photometer (Clements, F. E : 1905 ; 38–63). The various criticisms to which the use of the photographic method of light comparison is open are well known to the writer, but it can be argued that there are just as many disadvantages occurring from the use of the photochemical methods such as Ridgway's Oxalic Acid Method (Ridgway, C. S. : 1918 ; 234), and the Postassium Iodide and Sulphuric Acid Method (*vide* Braid, K. W. : 1923 ; 54–59, for description and refs. : also Bews and Aitken : 1923 ; 33–44). With reference to the photographic method it is admitted that a great disadvantage is that no expression of the light-intensity in absolute terms is possible ; at most, an impression of the relative densities of canopies can be obtained.

The general criticism advanced is that the quality of the light is modified in passing through the leaves of the various layers—the yellow and green being absorbed to a lesser degree than the red and blue violet and ultra-violet rays—and that therefore as the photographic paper is really darkened by the highly refrangible blue, violet, and ultra-violet rays, the light values obtained by its use are very much too low. Spectroscopic study of the light in forest has been made, principally by Zedebauer (1907 : 325–330); and Knuchel (1914, 1915 ; 90). certainly shows that the light is *very slightly modified* as it passes from layer to layer. It must be admitted, however, that the greater proportion of the light reaching the floor is not *transmitted* through the leaves, but is *direct and diffused light that passes unchanged in quality*, between the leaves.*

In the instance of the Podocarpus spp. at the Knysna, the amount of light passing thorugh the leaves is insignificant, light within the crowns of these trees and below them *being practically unaltered white light*. Thick, dark-green, more or less horizontally placed leaves such as those of Olea laurifolia, Pterocelastrus variabilis, Cunonia capensis, and Ocotea bullata, transmit slightly more light than those of the Podocarps, the greatest transmission being shown by such species as Apodytes dimidiata, Rhus laevigata, Celtis rhamnifolia, Plectronia Mundtii, and Halleria lucida. Even the ground vegetation, consisting largely of Trichocladus shoots, of Hemitelia and of other ferns, transmits exceedingly minute amounts of light. On the whole, reduction in amount of light is very considerable, change in quality, slight, and it is doubtful whether the slight change in quality has any appreciable influence upon plant growth, for photosynthesis principally takes place in the usually not considerably cut down blue and red rays ; very considerable change in the composition of the light would have to be brought about ere this function was much influenced.

The only light-intensity data hitherto available for South African forests are those of Bews (1912) and of Bews and Aitken (1923 : 41–43).

The present writer for three years has been working on the subject of relative light requirements of the more important forest trees of the Knysna, employing experimental light-intensity screens. The data obtained are to be published at a later date.

Humidity and Precipitation.

(a) *Humidity.*—The same remarks apply to the readings of dry and wet bulb thermometers constituting the standard hygrometers of the Union of S.A. Meteorological Office as to the readings of the maximum and minimum thermometers ; the data available from the stations at George, Knysna, and Storms River are unsatisfactory and contain many blanks.

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* Observations, by means of a simple spectroscope (direct vision), made by the writer certainly support this view. The subject requires special investigation.

Since 1923 reliable observations have been carried out at Deepwalls Research Station and at Belvidere; in addition one year's data are obtainable from Kaffirkop, and one year's from Harkerville.

At Deepwalls humidity data have been collected under various conditions of canopy and on several aspects, while relative humidity hygrograms produced by a recording hair hygrometer are available for the base station. More recently an Assmann psychrometer has been used for the measurement of humidity under field conditions.

In *Table XIX* humidity data for Deepwalls, Belvidere, Kaffirkop, and Harkerville are given, while in *Table XX* the humidity of two sites on the northern aspect of a hill at Deepwalls is compared—*one site being under forest canopy, the other experiencing full insolation. Table XX*A sets forth the occurrences of relative humidities lower than 40 per cent for the stations described in *Tables XIX* and *XX*.

As examples of the weekly run of humidity, two hygrograms by a hair-hygrograph situate at Deepwalls under full exposure, four feet above the ground, are given—No. 1 for a typical week without "Bergwinds," No. 2 for a typical "Bergwind" week. Both hygrograms bring out the general high humidity of the region, while No. 2 graphically indicates the influence of the "Bergwind" in reducing atmospheric humidity.†

Within the humid region under study, any sudden drop in humidity or any prolonged period of low humidity, produces scorching of foliar shoots and of inflorescences of exposed plants, and wilting and death in exposed or partially-exposed seedlings of the more delicate spp. In this connection the responses made by a forty feet high Olinia cymosa and by a fifty feet high Ocotea bullata, to falls in humidity (during "Bergwind" weather) is well shown in the three dendrograms attached. These were produced by a MacDougal Dendrograph.* The rises and falls in the traced line indicate diameter increases and decreases respectively, and it is noteworthy that marked falls in diameter are coincident with marked falls in humidity, while marked rises in diameter are to be correlated with high humidity.†

(b) *Precipitation.*—The rainfall within the region is fairly well distributed over the months of the year, there being no marked wet or dry periods.

The geographical situation of the region, lying as it does between regions of winter and of summer rainfall, is undoubtedly responsible in high degree for this regular distribution.

The key to the distribution of the rainfall west and east of the region is to be found in the positions, movements, and behaviour of the permanent regions of high barometric pressure (anticyclones) lying off the west coast of Cape Province and off the east coast of the country, between it and Australasia. In addition to the usual monthly lateral movements, these anticyclones with the annual movement of the sun, move northward and southward. In April and May the lateral movement of the western anticyclone is eastward, that of the eastern, westward and coastward. Simultaneous with these movements is the advent inland of a large secondary anticyclone, the pressure of this "high" increasing for several months, i.e., until about July. The western and south-western coastal regions of the Cape Province, as a result of the movement northward of the zone of low barometric pressure, experience in winter, rain-bearing, western winds associated with the depressions belonging to the system of low-pressure to the southward. The reason that these western winds do not water a larger area of ground is that they arise in and blow over portions of the Atlantic Ocean which possess a relatively low temperature, and therefore do not take up large amounts of moisture.

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* *Vide* Phillips, 1927; (5) for details; the instrument was kindly supplied by Dr. I. B. Pole Evans. † *Vide* Diagrams 1–13.

What they do contain is speedily expended on its being condensed against the slopes of the plateaux. Within a few months—during September and October—the anticyclone inland migrates to the Southern Indian anticyclone, the latter then proceeding eastward to its summer position immediately off the West Australian coast, and the South Atlantic zone of high pressure lying just off the west coast of Cape Province. Associated with the Indian cyclone are the rainbearing N.E. and E. winds which supply the summer rainfall to the greater portion of Southern Africa. Unlike those associated with the cyclones of the western coast, these winds originate in a warm ocean, and carrying a considerable amount of moisture, precipitate the larger portion of it as they traverse the plateaux of the interior. The region under special study receives rainfall from winds associated with both the western and the eastern permanent cyclones just described.

The region is classified by Buchan (1897) as being partly of the 20–30 inches-per-annum type and partly of the 30–40 inches-per-annum type (mean annual rainfall), and by Cox and Marloth (1923: Map No. 2), as partly of the 25–35 inches-per-annum type and partly of the 35–50 inches-per-annum type.

In *Table XXI* are given rainfall averages for fifteen stations in or just beyond the borders of the region, together with the average numbers of rainy days (more than 0·01 inches in 24 hours) per annum.

Mossel Bay, immediately west of the region, Uniondale north to north-east of it, and Humansdorp immediately east of it, show average catches lower than any in the region if the catch on the littoral at Plettenberg Bay be excepted. In *Table XXIII* are given monthly totals for five stations within the region, for the years 1923–25.

Reference to the positions of these stations reveals the fact that there is a steady increase in catch as the higher altitudes, on the upper plateau, are approached. It is a matter of common experience that sunshine may prevail at the littoral, while either dense mist envelops the upper plateau and the mountain barrier behind it, or rain actually is falling thereon.

Mists are of frequent occurrence in the higher portions of the region—at altitudes ranging from 1,000 feet upward. These hydrometeoric mists (Nebelreissen) contribute very appreciably to the total moisture catch, for they precipitate large amounts of moisture upon cool surfaces such as vegetation in its various forms, and on outcrops of rock along the mountain faces. Usually these mists are accompanied by either south-eastern or north-western winds, ranging from 1 to 3 force, Beaufort Scale. So dense are they at times that objects a yard distant are scarcely discernible. Immediately the mists envelop the forests, condensation takes place, and within a few minutes a steady drip of moisture from the foliage sets in.

Outside the forest at the same time condensation takes place on the plants of the macchia, but unless these be fairly high, the observer may remain perfectly dry, whereas within the forest he would have been drenched within a short space. In a word, forest on account of its greater height, condenses more moisture during misty weather, than does the shorter macchia. It is obvious then that rainfall measurements based upon readings of ordinary, fully exposed gauges, do not truthfully reflect the total amount of moisture actually falling to the ground. Marloth (1903: 403–408; 1905: 97–105) studied this interesting subject a number of years ago on Table Mountain, in connection with the south-eastern clouds.

He used two 5-inch raingauges, one of which bore a one foot-high framework made of netting-wire and of four vertical wire supports, through which framework seventeen Restionaceous stems were drawn, the other being an ordinary control gauge. Summarizing, we learn that the control gauge registered in

56 days approximately 4 inches of water, the condensation gauge, 80 inches—or approximately an increase of 1,500 per cent on the control. The difference amounted to 300–400 per cent. during ordinary precipitation, but during misty weather reached 1,000–1,200 per cent. Marloth (loc. cit.) further showed that the condensation gauge when placed in the midst of macchia, caught about $33\frac{1}{3}$ per cent., and when placed in the midst of reeds, 12·5 to 25 percent., respectively, the catch of the open control being taken as 100 per cent. More recently, Horton (1919 : 603–623) and de Forest (1923 : 417–419) working in Albany, New York, and in Maryland, respectively, have paid attention to this subject, but more particularly to the related subject of rainfall interception by plants. Several of their conclusions are worthy of notice : Horton, working with trees, concludes that 40 per cent. of the rainfall is intercepted by them, while the interception loss by large field crops approximates this figure. De Forest's results, together with those of Marloth, lead him to doubt whether an actual interception loss produced by vegetation, does occur. He even favours the opinion that interception gains are the result of condensation, in the instances of certain types of hydrometeors and certain types of vegetation.

The present writer has experimented on both aspects of the subject, and the results are certainly interesting, although a full explanation of them still remains to be found.

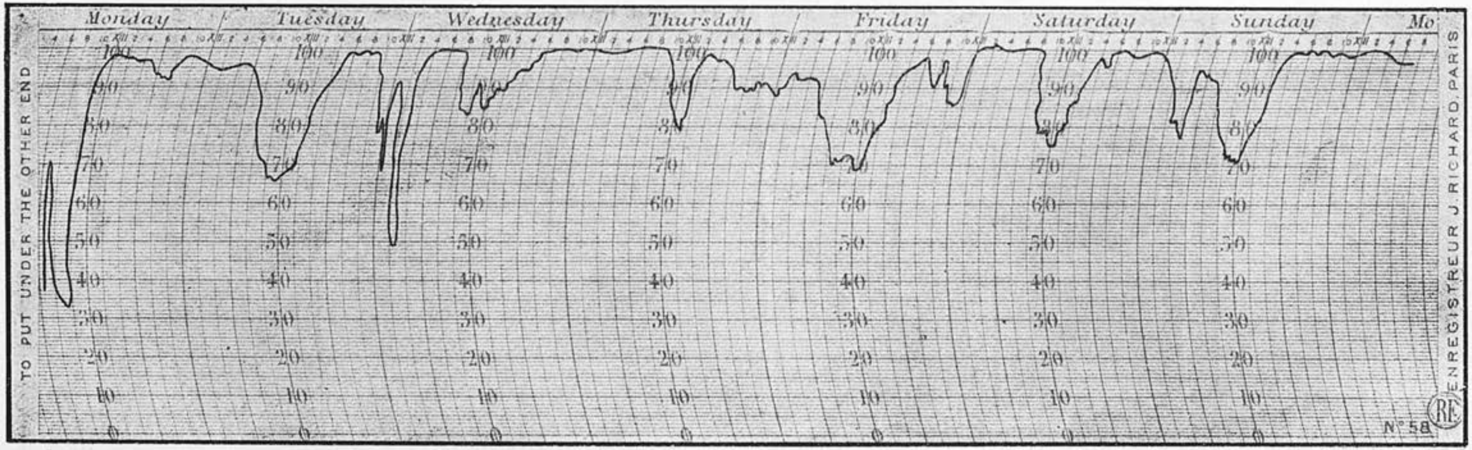
With reference to the condensation of hydrometeors—two 5-inch gauges mounted with their rims four feet above the ground, and ten feet apart, were placed on an exposed hill top at an elevation of about 1,700 feet. The gauges were perfectly free from interfering trees or other objects. One served as a control, the other bore a one foot-high frame of wire and mesh identical with that described by Marloth (loc. cit.) ; through the mesh were drawn four single branchlets of the broad-leafed conifer, Podocarpus Thunbergii Hook ; each branchlet bore approximately thirty leaves of from 2–3 inches in length by about $\frac{1}{3}$-inch in width. The branchlets were so arranged that the foliage was held in one and the same position by the wire mesh.

The tops of the branchlets were placed a quarter of an inch below the top rim of the frame. In this manner an evenly constituted mosaic of foliage was exposed all round the mouth of the gauge. Care was taken to keep the foliage in position, but owing to the persistent nature of the material and the toughness of the leaves, practically no alterations were necessary during the course of the twelve months long experiment. Records obtained by means of the gauges are summarized in *Table XXIII*. From these records it is seen that in one year the control caught 52·02 inches of moisture (100 per cent.), whereas the condensation gauge registered 94·56 inches (181·7 per cent.), and that for every month of the year with the single exception of February, 1926, the total was greater for the condensation gauge. From the classification of rain-types the large percentage (79 per cent.) of rains of fine, misty nature, is well shown, normal showers (13 per cent.) and heavy downpours (8 per cent.) being of relatively uncommon occurrence. As it is during the rains of misty nature that the condensation gauge registers the greatest catches as contrasted with the exposed gauge, it is evident that the part played by vegetation in condensing the hydrometeoric mists is a most important one.

From observations the writer agrees with de Forest in the supposition that the degree of interception gain depends upon the amount of water carried past the gauge in a given time, as well as upon the angle of fall and upon the velocity of the wind.

So far as actual interception loss is concerned, the following description of an experiment extending over several years is of interest :—

A 5-inch gauge was erected under canopy of climax forest (Podocarpus elongata, Olea laurifolia, Olea capensis, and Trichocladus crinitus formed the



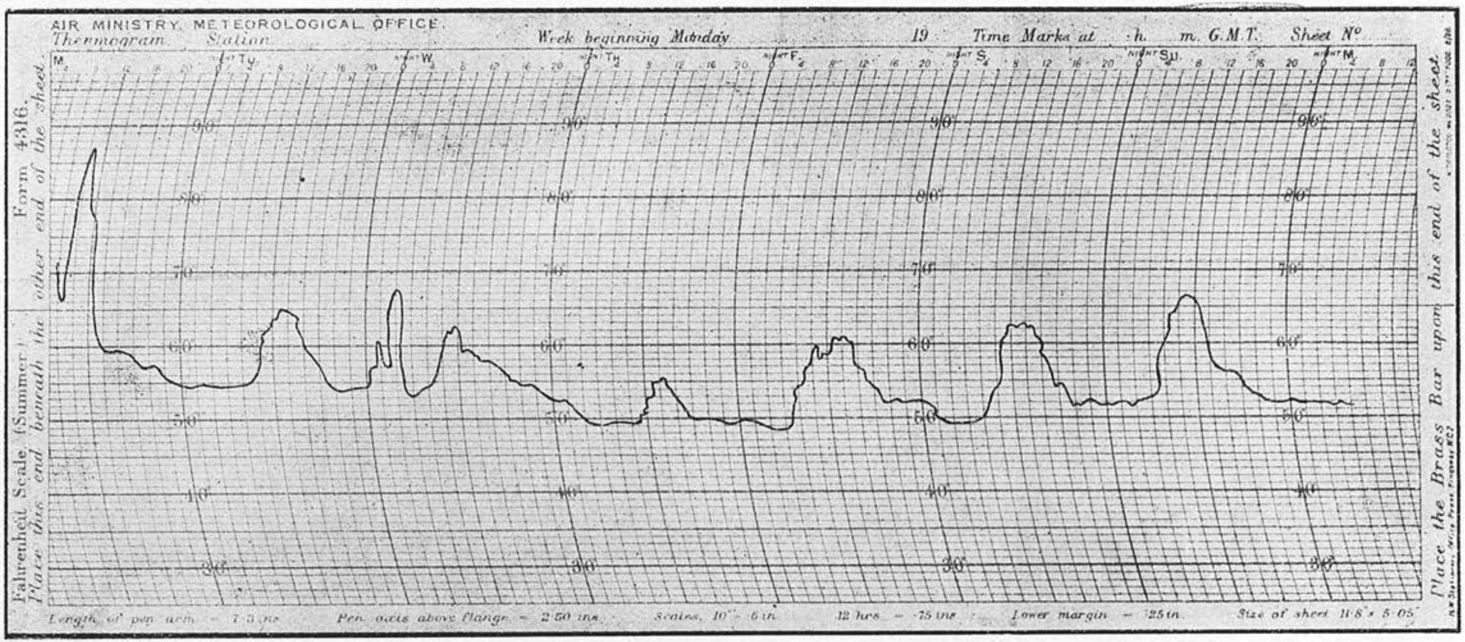
I. Hygrogram No. 135.

Forest Research Station, Deepwalls.

(The Hygrograph in a Stevenson Screen 4 ft. above ground.)

An example of the relative humidity conditions during a week without "Bergwinds". (31.8.1925-7.9.1925.)

Vide pp. 46, 52.



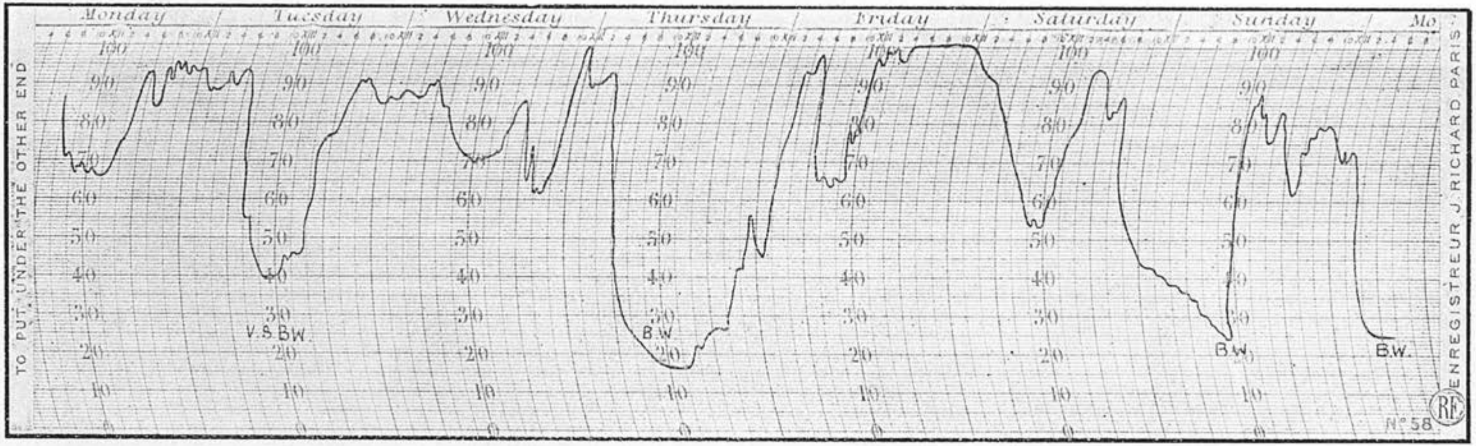
I. Thermogram No. 134.

Forest Research Station, Deepwalls.
(The Thermograph in a Stevenson Screen 4 feet above ground.)

Accompanying Hygrogram I.

An example of the temperature conditions during a week without "Bergwinds". (31.8.1925-7.9.1925.)

Vide pp. 46, 52.



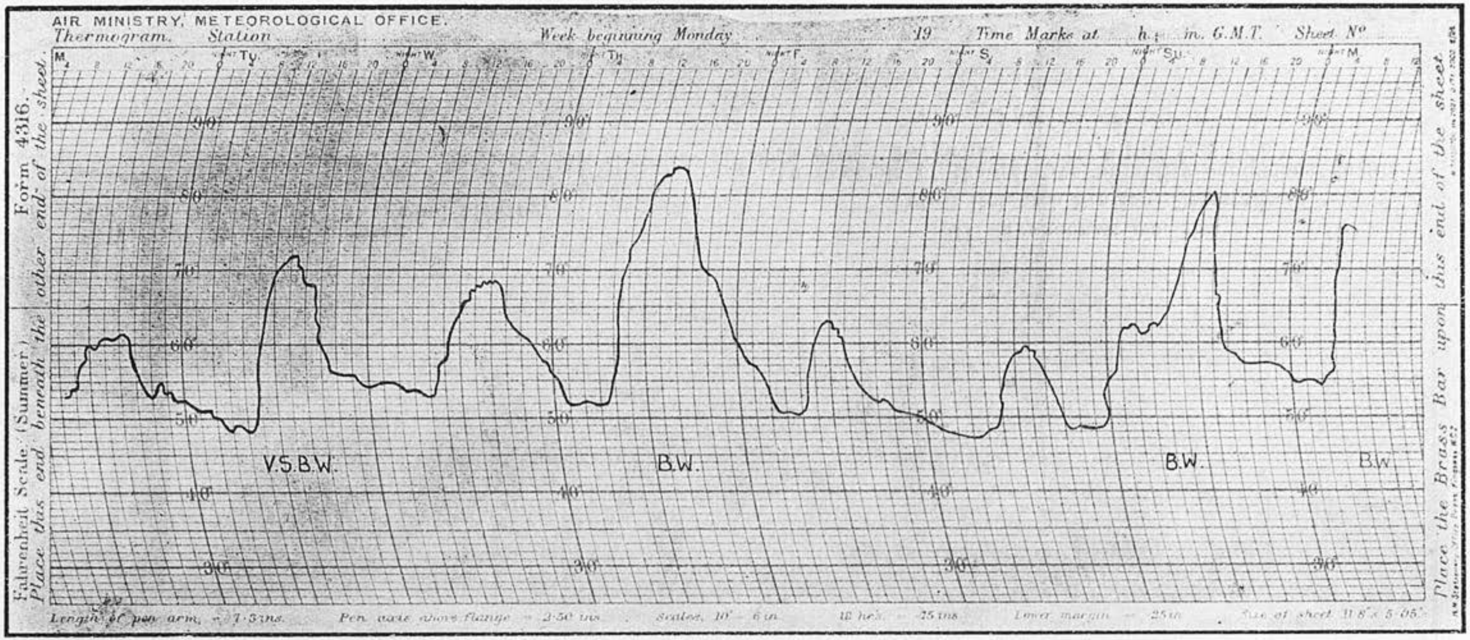
B.W.: Bergwind blowing.
V.S.B.W.: Very slight Bergwind blowing.

II. Hygrogram No. 133.

Forest Research Station, Deepwalls.

An example of the relative humidity conditions during a week with "Bergwinds". (17.8.1925-24.8.1925.)

Vide pp. 46, 52.



B.W.: Bergwind blowing.
V.S.B.W.: Very slight Bergwind blowing.

II. Thermogram No. 132.

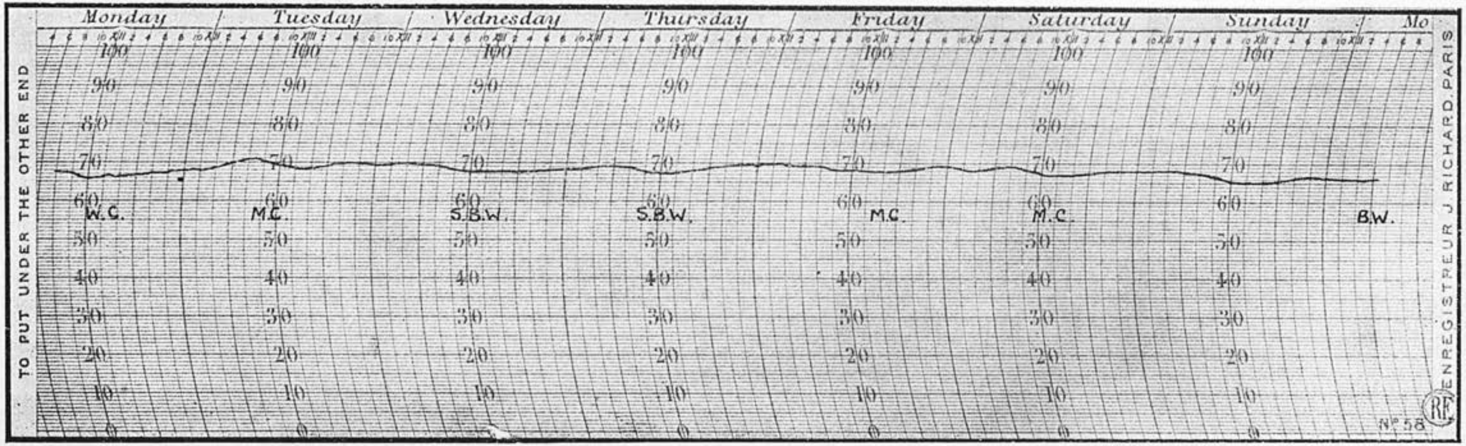
Forest Research Station, Deepwalls.
(The Thermograph in a Stevenson Screen 4 feet above ground.)

Accompanying Hygrogram II.

An example of the temperature conditions during a week with "Bergwinds". (17.8.1925-24.8.1925.)

Vide pp. 46, 52.

V.



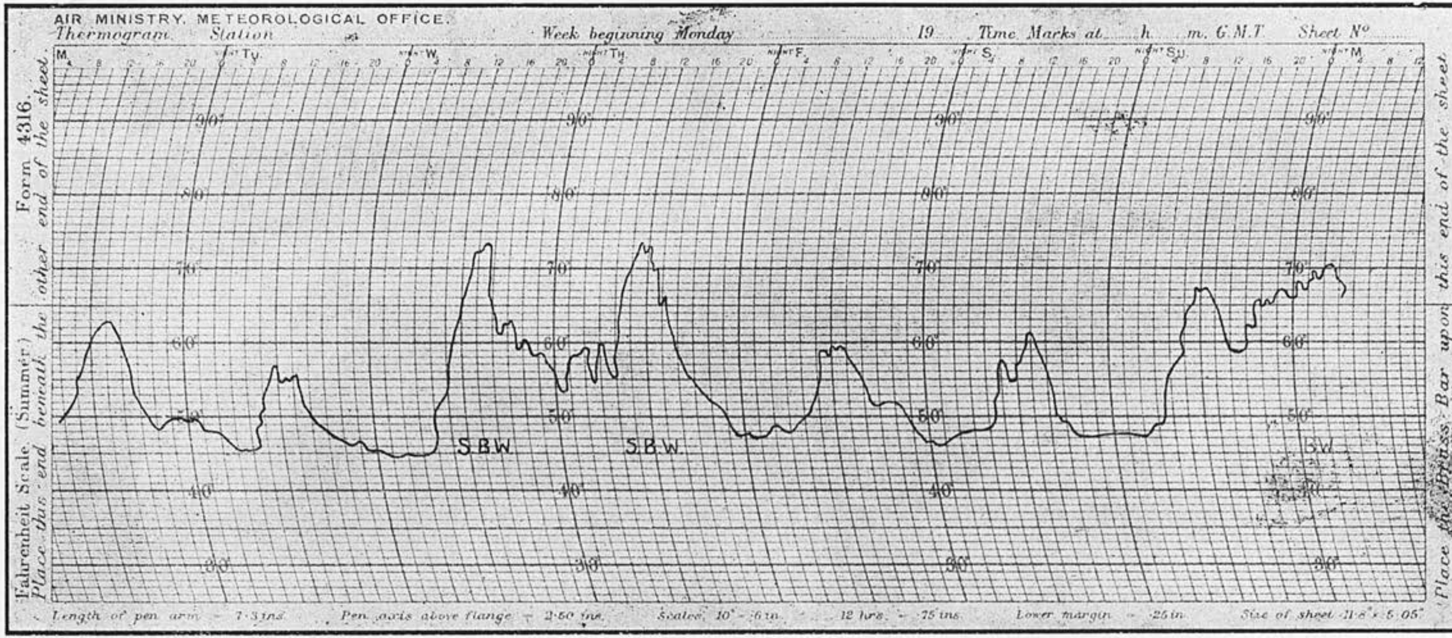
NOTE.—*Diameter variations magnified* × 10.

B.W.: Warm, clear.
M.C.: Moist, clear.
S.B.W.: Slight Bergwind blowing.

I. DENDROGRAM, *Olinia cymosa* Thunb; $4\frac{3}{4}$ ft. from ground.
Forest Research Station, Deepwalls.

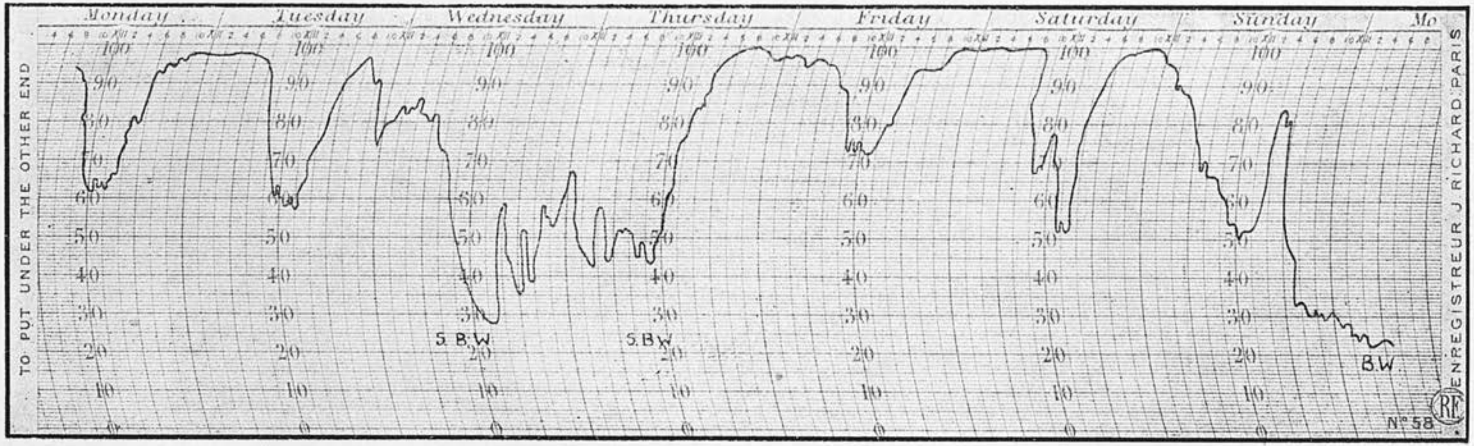
An example of the diameter variations each day during the period 9.8.1926-16.8.1926, and showing the reduced diameter during "Bergwinds".

Vide pp. 46, 52.



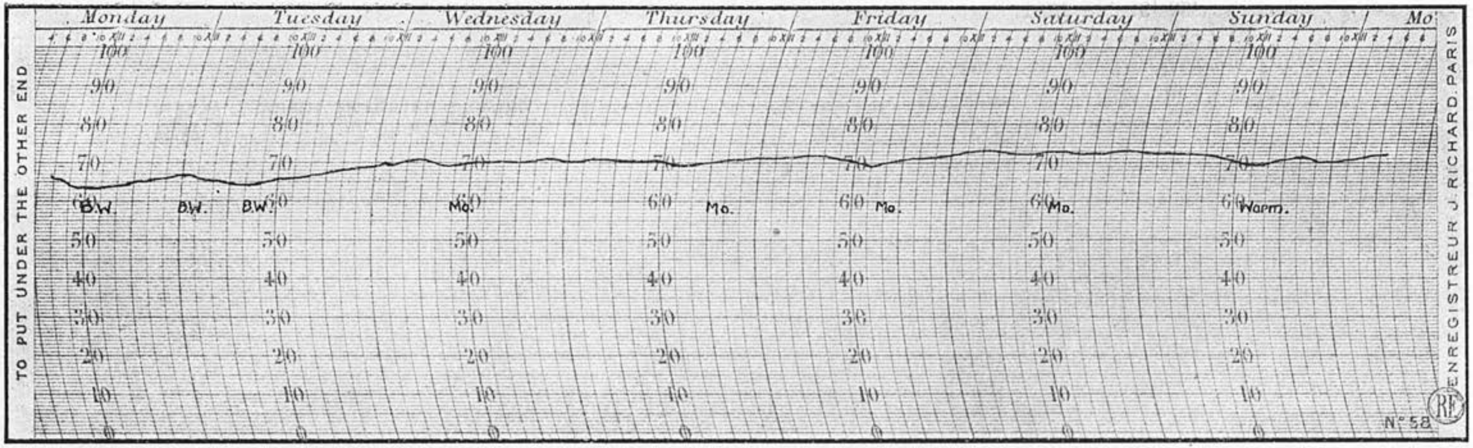
B.W.: Bergwind blowing.
S.B.W.: Slight Bergwind blowing.

III. THERMOGRAM No. 183.
Forest Research Station, Deepwalls.
Accompanying Dendogram I.
(9.8.1926-16.8.1926.)
Vide pp. 46, 52.



B.W.: Bergwind blowing
S.B.W.: Slight Bergwind blowing.

III. Hygrogram No. 184.
Forest Research Station, Deepwalls.
Accompanying Dendrogram I.
(9.8.1926-16.8.1926.)
Vide pp. 46, 52.



NOTE.—*Diameter variations magnified* × 10.

B.W.: Bergwind blowing.
Mo.: Moist.
W.: Warm.

II. DENDROGRAM, *Olinia symosa* Thunb. at $4\frac{1}{4}$ ft. from ground.

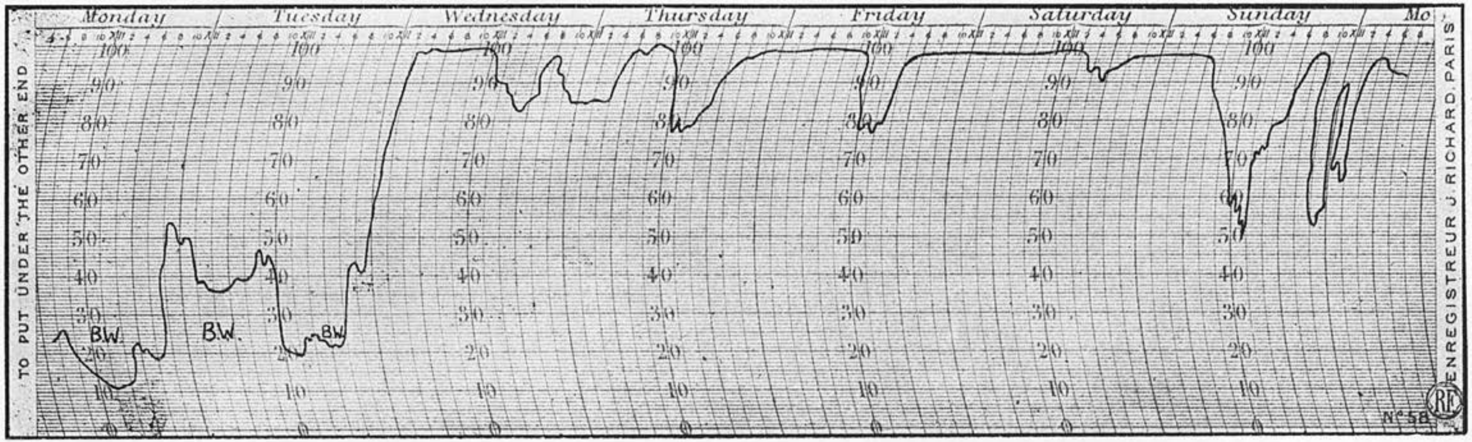
Forest Research Station, Deepwalls.

An example of the diameter variations each day during the period 16.8.1926-23.8.1926, and showing the reduced diameter during "Bergwinds".

Vide pp. 46, 52.

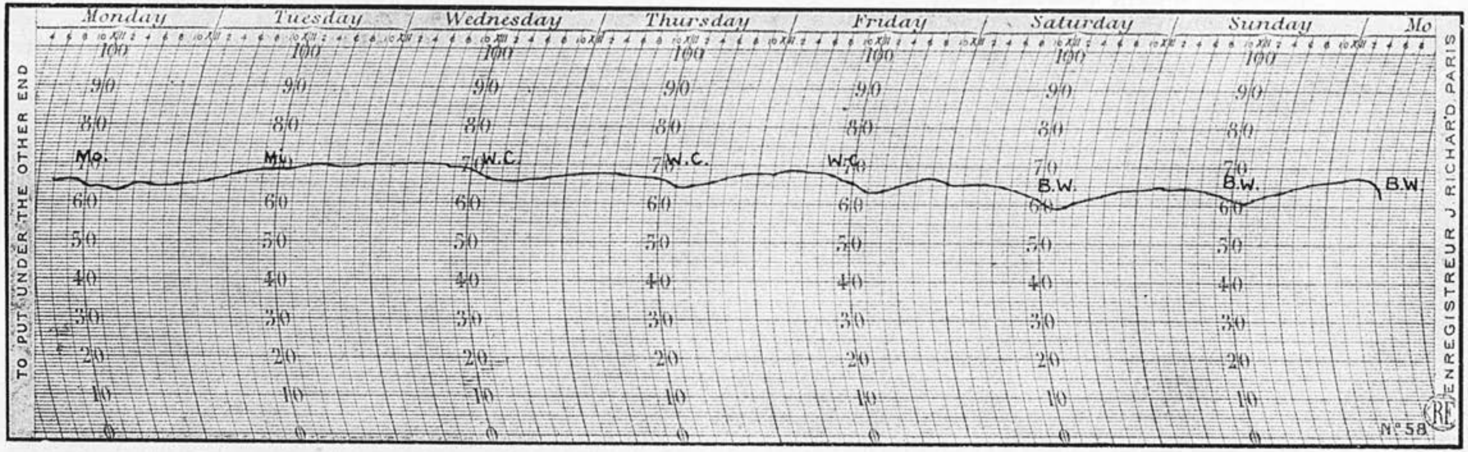
B.W.: Bergwind blowing.

IV. THERMOGRAM No. 184.
Forest Research Station, Deepwalls.
Accompanying Dendrogram II.
(16.8.1926-28.8.1926.)
Vide pp. 46, 52.



B.W.: Bergwind blowing.

IV. Hygrogram No. 185.
Forest Research Station, Deepwalls.
Accompanying Dendrogram II.
(16.8.1926-23.8.1926.)
Vide pp. 46, 52.



NOTE.—*Diameter variations magnified* × 10.

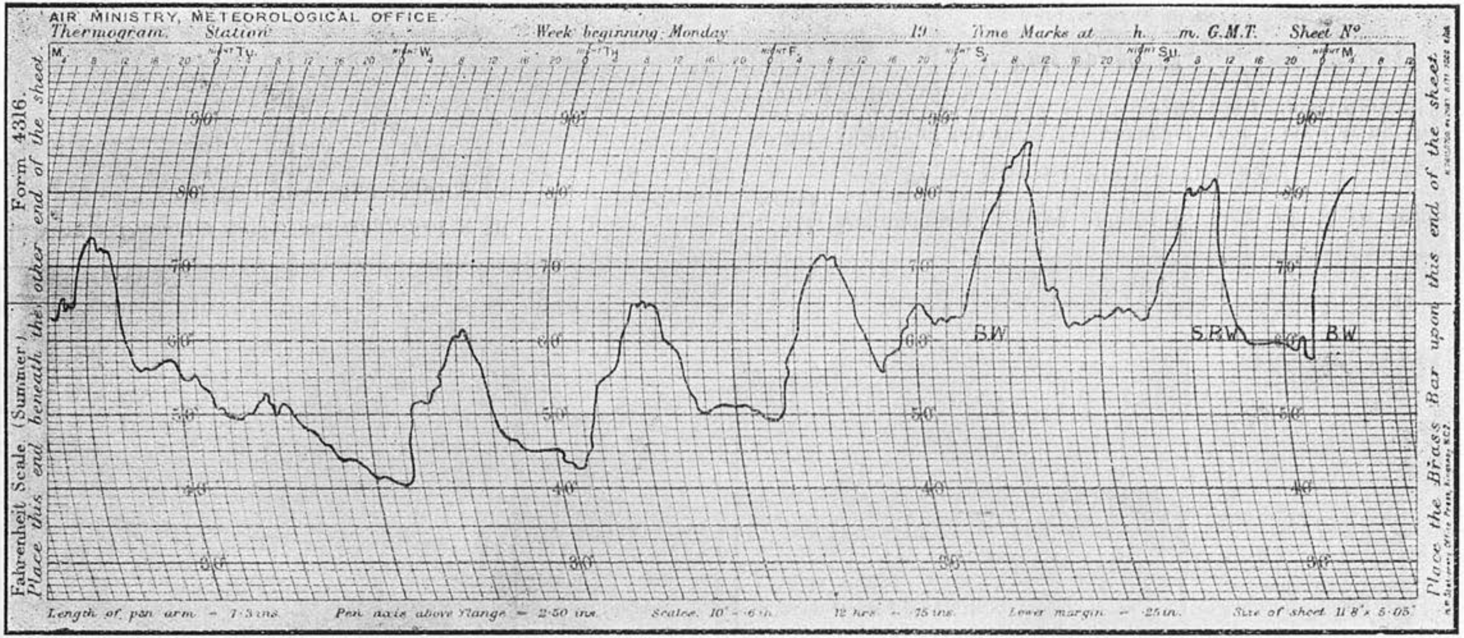
B.W. : Bergwind blowing.
Mo. : Moist.
Mi. : Misty.
W.C. : Warm, clear..

III. DENDROGRAM, *Ocotea bullata* E. Mey, at 4¼ ft. from ground.

Forest Research Station, Deepwalls.

An example of the diameter variations eac hday during the period 4.10.1926-11.10.1926, and showing the reduced diameter during " Bergwinds ".

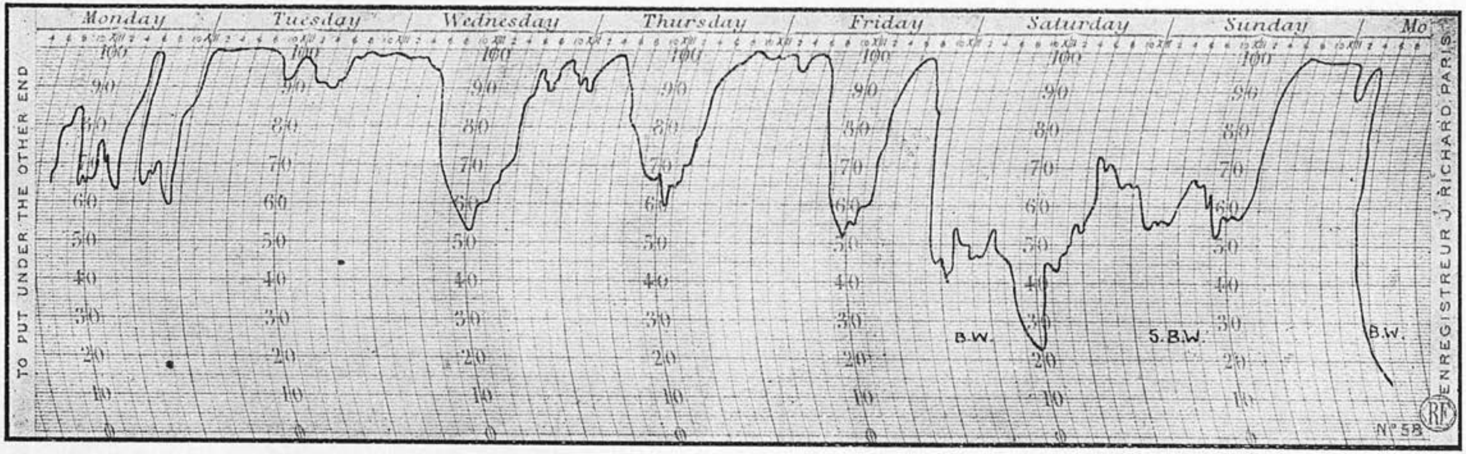
Vide pp. 46, 52.



B.W.: Bergwind blowing.
S.B.W.: Slight Bergwind blowing.

V. Thermogram No. 191.
Forest Research Station, Deepwalls.
Accompanying Dendrogram III.
(4.10.1926-11.10.1926.)
Vide pp. 46, 52.

XIII.



B.W.: Bergwind blowing.
S.B.W.: Slight Bergwind blowing.

V. Hygrogram No. 192.
Forest Research Station, Deepwalls.
Accompanying Dendrogram III.
(4.10.1926-11.10.1926.)

Vide pp. 46, 52.

actual cover near the gauge), the rim being four feet above ground. The readings taken at 8.30 a.m. were compared with those taken at the fully exposed base gauge, 200 yards distant. In *Table XXIV* the records for the canopied gauge are given, for the period February, 1923–January, 1925 (for monthly totals for the same period for the exposed gauge, vide *Table XXII* "Deepwalls"). For the 11-month-period, February, 1923–December, 1923, the total catch registered by the canopied gauge was 32·84 inches, whereas that shown by the control was 37·63, i.e., these catches are to each other as 87·2 : 100; for the 12-month-period, January, 1924–December, 1924, the catches are 30·85 inches for the canopied gauge and 44·20 inches for the control, i.e., they are to each other as 69·8 : 100. A comparison of the numbers of days with more rainfall than 0·01 inches, for the two gauges reveals the fact that for the 2-year-period, February, 1923–January, 1925, the canopied gauge experienced 58 days less than the control.

The data submitted, together with data still being collected, at Deepwalls lead the writer to differ from de Forest when he doubts the occurrence of nterception loss.*

The subject of total and of efficient rainfall has been receiving some of the attention it deserves—more especially in America (*vide* Drought Commission Report, 1923: 44–46 for a general account; also Cannon, W. : 1924). At the Knysna, loss of rainwater through run-off is not considerable, owing to the dense cover of forest and of scrub, bush, and macchia. As the country is not a stock-raising one, and as there are numerous, well-distributed watering places for the relatively few cattle and sheep that are kept within the region, but slight damage has been caused by the formation of paths serving as nuclei for the development of "sluits" and "dongas" through the forces of erosion. At the same time it is very necessary to emphasize that where undue burning of macchia and over-exploitation of forest on steep slopes, have been carried out, much local erosion does take place until the pioneer plant communities have recovered the ground. Miniature "bad lands," the result of severe local erosion, occur on the sites of disused roads descending steep declines.

Lysimetric observations [employing the type of lysimeter suggested by Hilgard (1912 : 227)] made in forest and macchia soils under perfectly natural setting, show that on undisturbed areas the bulk of the fall is absorbed by the porous humus layer, and percolates downward through soil and subsoil. Naturally, localities with steep slopes surrender a certain amount of the fall to run-off, which finds its way to the innumerable streamlets of the region, but the loss so incurred is quite insignificant (less than 5 per cent.) compared with the total annual rainfall. Evaporation losses are discussed under *Evaporation* further on in this Chapter.

Snow and hail as forms of precipitation require mention at this stage.

Snow very rarely falls upon the upper plateau and foothills, but annually falls occur upon the summits of the Outeniqua-Zitzikamma ranges. The snow on the summits seldom lies for more than several days. In *Table XXV* are given snow records for the region for the period 1922–26; during 1926 a heavy fall occurred, covering portions of the upper plateau from three to six inches in snow. Montane Forest patches suffer from snow-breakage annually, the most susceptible species being the flat-crowned Platylophus and the brittle Virgilia; Curtisia faginea and Apodytes dimidiata foliage is sometimes desiccated if bright sunshine follow the fall—the foliage turning brown and ultimately falling.

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* *Vide* Phillips, 1926: (5); 1928: (3); 1928: (8) for further notes on condensation and interception.

Hail storms are so few and far between that their occurrence is the cause of popular interest. Large stones (greater than a quarter-of-an-inch in diameter) have not been seen by the writer; the falls are of short duration and of no severity. The damage done to vegetation is altogether insignificant. *Table XXVI* sets forth hail records for Deepwalls.

Thunderstorms are of rare occurrence, the number of storms recorded 1923–25 being as follows:—

Stations.—Deepwalls, Kaffirkop, Harkerville.

Year.	Thunderstorms.	Lightning.	Remarks.
1923	3	Sheet: slight	Downpour slight.
1924	2	Sheet: slight	Downpour moderate.
1925	3	Sheet with slight Fork	Downpour moderate.

The lightning seldom strikes vegetation—very occasionally portions of the forests and macchia being "struck." In forest the work of this factor is very well marked: dead trees standing on small portions of ground on which the ground-vegetation is usually dry.

The subject of influence of drought periods upon the forest formation deserves some discussion.

As the rainfall in the region is comparatively heavy, and is usually fairly well distributed over the months of the year, the vegetation readily shows the effects of even a very short period of drought. Three to four weeks of warm weather without any rain, or with but slight showers, produces detrimental results so far as many of the more mesophytic herbs are concerned; ferns in the least exposed, suffer, while a few of the larger trees (e.g., Olea laurifolia) too, reflect the changed conditions in the appearance of their foliage, which either thins out, or yellows slightly, and assumes a wilted aspect. The mosses and lichens in the depths of the forest, too, register the drop in humidity by drying and shrinking. The most notable result, however, is produced in the large, woody shrub Trichocladus crinitus, the large, thin, rufescent leaves of which become flaccid on the first signs of drought; death of the plant takes place if the dry weather be prolonged.

While it is exceedingly seldom that the holard* of forest soil falls within 5 per cent. of the wilting coefficient, death of regeneration of such species as Ocotea bullata, Apodytes dimidiata, Platylophus trifoliatus, and Cunonia capensis is brought about by reduced moisture conditions under full exposure, and under dense layers of the shrub Trichocladus.

Study of the growth-rings of such species as Podocarpus elongata L'Herit., P. Thunbergii Hook, Apodytes, Elaeodendron croceum, and Curtisia faginea, has failed, so far, to reveal the annual nature of these; some rings seem to be produced in one year, while others appear to be the product of several years, and yet others, the product of several months only. At all events the occurrence of several rings exceptionally close together and almost constituting a single zone, seem to mark the occurrence of periods of minute increment, *possibly corresponding with periods of reduced rainfall.* (Temperature fluctuations are so slight, season for season, that little likelihood exists of their being the causal factor of the formation of these zones.)

A point of great importance is that although the forest and macchia soils are naturally of high moisture content and of relatively heavy nature, they, on exposure to insolation, readily part with the greater portion of their moisture, rapidly pulverizing to a black or pale-grey mass. Under canopy these soils during dry weather, do not retain their moisture for long.

* Total water-content of the soil, on basis of oven-dry weight.

Exceptional droughts have been recorded for the following years: 1869, 1881, 1891, 1895, 1899. The greatest of these was that of 1868–69: it is recorded that no rain fell for the space of three months, and that "Bergwinds," while exceptionally frequent, were not followed by the customary humid conditions.

By February, 1869, the macchia and the forests were filled with dead and dying plants, and with much inflammable debris. A holocaust by fire was visited upon the region on the 10th and 11th February, resulting in the devastation of thousands of acres of forest (*vide* references given on the vegetation maps for the region), of macchia, and of agricultural land, and in the destruction of human habitations, and in the death of wild and domesticated animals.

1899 saw the second severest drought on record: "Bergwinds" again played havoc with the vegetation for the space of several months, drying it out to considerable degree. Large trees of Olea laurifolia and of Apodytes died for lack of moisture, while birds and mammals are said to have died in the forests, from thirst.

Few and far between as these drought periods are, it must be remembered that operating through the ages as they have, they must have wielded a potent influence upon forest succession. One extreme season is capable of undoing the growth and development of communities produced by many normal years; direction of succession, too, can be influenced, one type of community of seral nature, being inhibited in its development, another escaping little scathed.

Wind.—The prevailing winds are those from the N.W. and S.E.; N.N.W., W. and S.W. winds being less frequent. Periodically the Foehnlike "Bergwinds" parch the countryside. A classification of winds according to direction is given in *Table XXVII*, while they are classified according to their forces in *Table XXVIII* (in terms of the Beaufort Scale, devised by Admiral Beaufort in 1805, and used extensively by all weather offices). The data are based upon observations at 8.30 a.m. and 7.0 p.m. during the years 1924 and 1925—at Deepwalls.

The "Bergwinds," to which frequent reference is made in this paper, require description.

These desiccating winds from the north and north-west are equivalent to those hot winds described by Mann in his "Guide to Natal," and by Bews (1912: 287–289; 1917: 526–527; 1920: 381–382; 1925: 8) for the same region. So far as the Knysna region is concerned, the "Bergwinds" were touched upon by McNaughton (1902) and by Sim (1907: 38), while Marloth (1908: 189) cites observations made by McNaughton.

According to descriptions of the *Chinook* wind occurring east of the Rocky Mountains, by H. M. Ballou (1892–1893: 541–547), of the *Foehn* of the Swiss Alps and of other mountainous regions in Europe and elsewhere, of the *Sirocco* of the Latin countries of Southern Europe, of the *Bora* of Istria and Dalmatia, and of the *Mistral* of southern France, so well given in outline by Hann (1903: 344–365), the *Bergwinds* are related to these as regards general nature of origin and certain major characteristics.

So far as can be ascertained from a perusal of relevant literature and a study of the pressure, temperature, and humidity phenomena occurring immediately before, during, and immediately after a "Bergwind," the peculiar nature of the wind is to be explained as follows:—

As a result of the distribution of barometric pressure, hot winds of low humidity blow coastward from off the warm, dry regions of the Karroo and the Orange Free State, particularly during the winter months. These winds commence as dry and warm, but by the time they have reached the coastal ranges, after having traversed miles of arid country, they are considerably drier and warmer.

The high humidity and low temperature of the coastal ranges are respectively lowered and increased by the winds from the interior.

In addition to the drying and heating produced in this manner, the air is further dynamically warmed by compression as it descends from the mountains to lower levels to take the place of air which flows out in response to the call of the cyclone or region of low barometric pressure lying off the coast. This increased heating brings about decreased humidity. While it is well known that air descending to levels of higher pressure has its temperature raised by compression—Hann (loc. cit.) states at the rate of 1 deg. C. for every 100 metres descent (the average decrease in temperature with rise in altitude being only 0·57 deg. C.)—certain details of this interesting process are veiled in obscurity, *for warm air does not flow downward naturally.*

Observations at Deepwalls have established the following points with reference to the hot, dry winds:—

(*a*) Thirty to forty "Bergwinds" occur per annum; while these are more frequent during the period April–September, they nevertheless do blow during the period October–March.

(*b*) The absolute maximum temperatures for the several months of the year, in most instances, coincide with the occurrence of "Bergwinds" (vide *Tables IV, V, VII, VIII, IX*, the temperatures in italics being recorded on "Bergwind" days).

(*c*) Days of absolute minimum humidity (or of absolute maximum saturation deficit) are wholly coincident with dates of "Bergwinds" (*vide* Hygrograms 1 and 2, and corresponding Thermograms for the same periods).

(*d*) Days of absolute maximum evaporation rate are almost wholly coincident with days of "Bergwinds" (vide *Table XXIX*, Absolute Maximum Evaporation column, and *Table XXX*, Evaporation on "Bergwind" days).

(*e*) Rain frequently follows "Bergwinds"; this appears to be due to the gradual or sudden moving of the wind from N. to N.W., and thence to W. and S.W., or from N.W. to S.W. and W. This veering round is accompanied by gradual or sudden decrease in temperature, increase in humidity, decrease in rate of evaporation; cloud-banks arise on the ocean, and hydrometeors soon appear over the forests of the plateaux. The parching climate of the morning, at noon may be replaced by a fresh, bracing, humid climate not unlike that of the British Isles. The cause of this change of wind direction is not very clear, but in part must be related to the moving N. and W. of the main barometric depression.

(*f*) Phytometric studies show that during "Bergwinds" plants, whether exposed or under canopy, transpire at higher rates than they do during the warmest of weather, the air being either comparatively still, or the S.E. wind blowing. The water loss is appreciable, and death of tender plants or of portions of plants is by no means uncommon.*

* *Vide* Dendrograms I, II, III.

(*g*) Natural vegetation after several days' " Bergwind " assumes a flaccid appearance. This is much more strongly marked in certain species than in others.

(*h*) Together with insolation factors and soil conditions, " Bergwinds " seem to have a controlling influence as to capture of localities by forest, N. and N.W. aspects of severely exposed positions often bear no covering but stunted macchia, while the S., S.W., and S.E. slopes of the same points or ranges are clad in either bush or forest. Even at lower altitudes, and in areas less insolated, well marked *aspect alternes* are found. How far these are to be attributed to " Bergwinds " it is difficult to say, but certainly examples are known where it would seem that the major role is played by these parching air movements.

(*i*) The winds are not commonly of high velocity, usually being describable by the Beaufort numbers 1, 2, 3; very occasionally 6 and 7 winds occur; at times winds of force 8 and 9 blow, these assisting in distributing light seeds over fair distances (*vide* Appendix I, Table 4 therein).

Rate of Evaporation.

Owing to the relatively low temperatures prevailing in the region, and to the usually high humidity of the air, the rate of evaporation is not excessive. During " Bergwind " weather, however, there is an appreciable increase in evaporation rate, owing to the increased temperature, decreased humidity, and the movement of the air. In 1922 the writer commenced the collection of evaporimetric data, employing the ordinary " free water surface " methods. A careful scrutiny of the results obtained decided in their abandonment as being of little utility, and in 1925 the Livingston spherical porous-cup atmometers were substituted (*vide* Livingston: 1915). Fitted with the Livingston-Thone valves (*vide* Thone, F., 1924), these atmometers do not absorb moisture from the wetted exteriors of the porous spheres, through destruction of the minisci in the pores.

In *Table XXIX* (*a*) are given monthly mean evaporation data (in cubic centimetres of distilled water) for the period July, 1925 to June, 1926, the atmometer being stationed 12 inches above the surface of the soil, under full exposure to insolation, 1,725 feet, Deepwalls Research Station. In *Table XXIX* (*b*) data for a second atmometer situate under canopy of light-intensity 1/80, and only 25 yards removed from the first instrument, are submitted. From a perusal of the monthly means and of the absolute maximum evaporation losses in 24 hours, it is seen that the losses in the open are consistently of a higher value than those under canopy, despite the slight distance that separates these sites. A feature of the greatest interest is the frequent coincidence of absolute maximum rates of evaporation and " Bergwinds," In *Table XXX* the daily (24-hour periods) evaporation losses registered by the atmometer under full exposure in August, 1925, are given, for sake of showing how the maximum losses are coincident with the occurrence of these parching winds.

Comparison of evaporation losses at the Knysna with those in other portions of South Africa is not possible, for apart from the data given by Cannon (1924), the data regarding evaporation in the Union are practically confined to losses from " free water surfaces " (*vide* Drought Commission Report, 1923: 47), which cannot be compared with data obtained by the Livingston atmometer.

(B) Zoo-Biotic Associates.*

The biotic features of the soil have already been described (*vide* Chapter I, 33–35), the influence of man is discussed in Chapter III, (99–193), while in Appendix I are described the parts played by biotic pollinators and agents of seed dispersal. It remains only to list the more important zoo-biotic associates, and to remark very briefly upon their functions: this is done in *Table XXXI* (pp. 94–96).

IMPORTANT FOOTNOTE.

* Since the above section was written the writer [*vide* Phillips, 1930; (1)] has somewhat developed the *biotic community* concept of Clements and Shelford, and has given examples from the Knysna region. *Plants and animals are considered as inter-related, co-acting, interdependent constituents of an integrated biotic community—that is, animals are not held as being biotic factors external to the plant community: the view of most plant ecologists.*

Table IV.

SUN TEMPERATURES AS OBTAINED FROM SOLAR RADIATION THERMOMETER WITH BLACK BULB IN VACUO.

Station.	Position.	Temperature. ° F.	Aug., 1925.	Sept., 1925.	Oct., 1925.	Nov., 1925.	Dec., 1925.	Jan., 1926.	Feb., 1926.	Mar., 1926.	April, 1926.	May, 1926.	June, 1926.	July, 1926.	Remarks.
Deepwalls, 1,725 feet	15 ins. above the soil	Mean monthly maximum	99·34	94·21	102·37	107·44	104·99	113·75	108·61	107·99	111·25	96·75	101·96	96·28	
	(Vegetation clad)	Absolute monthly maximum	*121·00*	*122·00*	*118·00*	125·75	*121·00*	125·00	129·00	*125·50*	*126·00*	*114·00*	*120·50*	*111·75*	Grand absolute maximum 129° F.*
Light intensity = full light		Absolute monthly minimum	60·50	70·25	79·25	73·50	73·00	77·75	75·25	74·75	69·00	77·50	72·50	51·75	

Italic Figures denotes Bergwind blowing.

* On 11·10·26, during a Bergwind (shade temp. max. = 100·5; relative humidity, 11 per cent.) the high sun temperature of 139·75° F. was registered.

Table V.

AIR TEMPERATURES (THERMOMETERS IN STEVENSON'S SCREENS): READ 8.30 A.M. DAILY.

Altitude and Position.	Station.	Temperature. ° F.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year: Abs. Max. Abs. Min.	Remarks.
10 ft. elevation	Belvidere....	Mean max. at 4 ft. above Ground	1923	76·40	76·70	76·67	71·36	67·00	65·99	64·40	67·40	67·08	70 96	72·67	75·84		
			1924	77·50	78·00	73·76	74·16	66·43	66·01	66·95	63·44	65·06	67·58	69·79	77·55		
			1925	76·20	81·04	76·93	72·70	70·60	65·23	66·30	69·35	66·98	68·31	71·60	73·91		
2 miles west of Knysna		Mean Min. at 4 ft. above ground	1923	58·50	61·20	60·24	55·53	47·80	46·27	45·40	44·90	49·25	54·46	57·70	59·12		
			1924	59·80	60·00	55·91	53·41	46·77	45·32	43·23	44·94	49·65	49·98	53·38	60·75		
			1925	58·80	62·80	61·20	52·39	47·00	45·09	46·00	47·88	51·60	52·25	55·06	57·42		
On edge of Estuary of Knysna River		Mean temp. at 4 ft. above ground	1923	67·45	68·95	68·45	63·44	57·40	56·13	54·90	56·15	58·16	62·71	65·18	67·48		62·20 Annual mean, 1923.
			1924	68·65	69·10	64·83	63·78	56·66	55·66	55·09	54·19	57·35	58·78	61·58	69·15		61·23, Annual mean, 1924.
			1925	67·50	71·92	69·06	62·50	58·80	55·16	56·15	58·61	59·29	60·28	63·33	65·66		62·35, Annual mean 1925., 61·92, Average for 3 years.
		Absolute max. at 4 ft. above ground	1923	*9·60*	*92·70*	84·50	*99·70*	*86·40*	*81·30*	*82·60*	*93·40*	*92·30*	89·30	80·20	86·60	99·70 (April)	
			1924	95·80	91·40	*99·10*	*96·00*	*80·80*	*84·90*	*84·80*	*78·20*	*79·50*	*86·00*	80·20	*92·50*	99·10 (March)	
			1925	*84·60*	*108·00*	90·10	*97·40*	*87·40*	*83·10*	*81·00*	*90·40*	*91·60*	*79·60*	81·20	*88·40*	108·00 (Feb.)	
		Absolute min. at 4 ft. above ground	1923	54·20	53·00	51·30	45·30	39·60	36·00	37·10	36·70	40·40	45·20	52·20	50·00		
			1924	51·00	52·10	42·80	43·50	39·80	35·50	37·40	36·50	39·90	40·90	45·90	49·20		
			1925	47·50	51·80	52·40	45·80	39·40	38·70	38·20	40·70	43·20	42·50	48·30	51·40		
		Mean range (Average, 1923–24–25)	—	1760	17·24	16·67	18·99	20·82	20·18	21·00	20·82	16·20	16·72	15·97	16·67		
		Absolute Range, 1923–24–25	—	48·30	56·20	56·30	56·20	48·00	49·40	47·70	56·90	52·40	48·40	34·30	43·30		72·50, Absolute range in 3 yrs.

Italic Figures denote Bergwind blowing.

Table V.—(Continued).

AIR TEMPERATURES (THERMOMETERS IN STEVENSON'S SCREENS) 4 FEET ABOVE GROUND READ 8.30 A.M. DAILY.

Altitude and Position.	Station.	Temperature. ° F.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year: Abs. Max. Abs. Min.	Remarks.
1,180 ft. elevation	Kaffirkop....	Mean max. at 4 ft. above ground	1923	73·09	74·4	73·1	69·0	64·8	63·9	62·1	68·0	65·3	66·8	67·3	72·8		
Exposed hilltop at edge of Main Forest Uplands Plateau		Mean min. at 4 ft. above ground	1923	57·74	55·6	59·4	55·3	51·2	49·8	49·2	48·56	49·9	53·4	55 4	57·0		
		Mean temp. at 4 feet above ground	1923	65·41	64·55	66·2	62·1	57·55	56·08	55·6	58·28	57·06	59·56	61·3	64·9		
		Absolute max. at 4 feet above ground	1923	*99·5*	*98·9*	88·8	*99·7*	*82·8*	*77·2*	*80·2*	*81·4*	*91·7*	89·5	78·0	88·0	99·7 (Apr)	
		Absolute min. at 4 feet above ground	1923	52·0	53·1	53·2	41·2	44·5	41·0	39·1	41·0	42·0	45·0	49·0	45·5	39·1 (July)	
		Mean range at 4 ft. above ground	1923	15·35	18·8	13·7	13·7	13·6	14·1	12·9	19·44	15·4	13·4	11·9	15·8		
		Absolute range at 4 feet above ground	1923	47·50	45·8	35·6	58·5	38·3	36·2	41·1	40·4	49·7	45·5	29·0	42·5		

Italic Figures denote Bergwind blowing.

Table V.—(Continued).

AIR TEMPERATURES THERMOMETERS (IN STEVENSON'S SCREENS) 4 FEET ABOVE GROUND READ 8.30 A.M. DAILY.

Altitude and Position.	Station.	Temperature. ° F.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year: Abs. Max. Abs. Min.	Remarks.
1,725 ft. elevation	Deepwalls.... (Base)	Mean max. at 4 ft. above ground	1923	—	72·94	71·60	66·69	61·46	60·33	58·70	64·85	64·10	67·87	68·26	71·25		
			1924	73·16	73·29	68·75	71·28	62·87	62·66	63·95	60·93	61·53	64·81	66·40	74·10		
			1925	74·93	78·15	72·98	68·59	66·51	60·37	61·50	69·36	62·38	65·31	68·62	71·36		
Exposed hilltop in midst of the Main Forest		Mean min. at 4 ft. above ground	1923	—	56·89	58·55	53 61	49·69	47·28	47·38	46·78	47·60	51·64	53·68	54·76		
			1924	58·66	56·97	53·56	54·46	49·11	47·55	48·35	45·97	47·35	48·29	50·07	57·81		
			1925	55·46	59·63	57·83	53·15	51·28	46·22	47·19	48·36	48·94	48·77	50·44	52·56		
De Vlugt Plateau		Mean temp. at 4 ft. above ground	1923	—	64·91	65·07	60·15	55·57	53·85	53·04	55·81	55·85	59·75	59·47	63·00		58·77, Annual mean, 1923. 59·24, Annual mean, 1924. 60 03, Annual mean, 1925. 59·34, Average for 3 years.
			1924	65·91	65·13	61·15	62·87	55·99	55·10	56·11	53·45	54·44	56·55	58·23	65·95		
			1925	65·19	68·89	65·40	60·87	58·89	53·29	54·34	58·86	55·66	57·04	59·53	62·46		
		Absolute max. at 4 feet above ground	1923	—	*94·50*	84·00	*94·25*	*76·75*	*73·00*	*74·60*	*86·90*	*88·50*	84·40	76·25	88·00	94·50 (Feb.)	
			1924	*91·25*	92·25	*88·00*	*94·50*	*81·75*	*80·25*	*78·25*	*77·25*	*86·00*	*86·50*	85·00	*93·25*	94·50 (Mar.)	
			1925	*83·25*	*102·75*	84·00	*91·00*	*82·00*	*73·50*	*74·25*	*90·25*	*84·75*	*84·75*	84·25	*84·75*	102·75 (Feb.)	
		Absolute min. at 4 feet above ground	1923	—	52·00	48·50	39·10	41·40	38·50	36·00	39·00	39·00	43·20	47·00	48·25	36·00 (July)	
			1924	48·00	50·00	42·50	45·25	40·75	36·25	39·50	38·25	38·25	41·50	40·50	50·25	36·25 (June)	
			1925	46·25	51·25	51·50	46·25	41·50	40·00	37·50	40·25	40·75	36·25	43·75	47·00	36·75 (Oct.)	
		Mean range (Average 1923–24–25)	—	16·98	16·96	14·46	15·14	13·58	14·10	13·74	18·01	14·70	16·43	16·36	17·19		
		Absolute range 1923–24–25	—	45·00	52·75	45·50	55·40	41·25	41·75	42·25	52·00	49·50	50·25	45·00	46·25		66·75 = Absolute range in 3 years.

Italic Figures denote Bergwind blowing.

Table V.—(Continued).

AIR TEMPERATURES THERMOMETERS (IN STEVENSON'S SCREENS) 4 FEET ABOVE GROUND READ 8.30 A.M. DAILY.

Altitude and Position.	Station.	Temperature. ° F.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year: Abs. Max. Abs. Min.	Remarks.
650 ft. elevation	Harkerville...	Mean max. at 4 ft. above ground	1925	—	—	—	—	—	—	—	—	—	66·1	69·7	70·1		
			1926	75·1	74·8	73·6	73·2	69·5	68·4	62·5	65·2	64·8	—	—	—		
On margin of Coastal Forest, Uplands Plateau		Mean min. at 4 ft. above ground	1925	—	—	—	—	—	—	—	—	—	50·0	52·8	54·4		
			1926	57·2	56·7	57·3	53·6	51·1	48·2	45·1	46·4	47·6	—	—	—		
3 miles from Sea (air line)		Mean temp. at 4 ft. above ground	1925	—	—	—	—	—	—	—	—	—	58·05	61·25	62·25		
			1926	66·15	65·75	65·45	63·4	60·3	58·3	53·8	55·8	56·2	—	—	—		
		Absolute max. at 4 feet above ground	1925	—	—	—	—	—	—	—	—	—	*76·10*	*82·00*	*81·00*		
			1926	*83·6*	*88·5*	*88·6*	*91·5*	*84·8*	*81·9*	*77·6*	*76·8*	*88·9*	—	—	—	91·5	
		Absolute min. at 4 feet above ground	1925	—	—	—	—	—	—	—	—	—	43·90	45·1	48·3		
			1926	51·9	52·5	46·2	44·0	41·5	40·7	37·2	35·4	40·7	—	—	—	35·4	
		Mean range at 4 ft. above ground	1925	—	—	—	—	—	—	—	—	—	16·10	16·9	15·7		
			1926	17·9	18·1	16·3	19·6	18·4	20·2	17·4	18·8	17·2	—	—	—		
		Absolute range at 4 feet. above ground	1925	—	—	—	—	—	—	—	—	—	32·20	36·9	32·7		
			1926	31·7	36·0	42·4	47·5	43·3	41·2	40·4	41·4	48·2	—	—	—		

Italic Figures denote Bergwind blowing.

Table VI.

OCCURRENCES OF FROST, DEEPWALLS AND BELVIDERE, 1923–1926.

Station.	Year.	May.	June.	July.	Aug.	Sept.	Oct.	Total for Year.
Deepwalls (1,725 ft.)...	1923	—	—	—	—	—	—	0
	1924	—	—	—	1 Mild	—	—	1
	1925	2 Mild	—	—	—	—	—	2
	1926	1 Mild	1 Mild	—	—	—	—	2
Belvidere (Sea-level)...	1923	—	—	—	—	—	—	0
	1924	—	—	—	—	—	—	0
	1925	—	—	—	—	—	—	0
	1926	—	—	—	—	—	—	0

AIR TEMPERATURES (THERMOMETERS IN STEVENSON'S SCREENS) NORTH AND SOUTH ASPECTS OF DEEPWALLS HILL.

Altitude and Position.	Aspect.	Temperature. F°	Height Above Ground.	Nov., 1923.	Dec., 1923.	Jan., 1924.	Feb., 1924.	March, 1924.	April, 1924.	May, 1924.	June, 1924.	July, 1924.	Aug., 1924.	Sep., 1924.	Oct., 1924.	Year. Absolute Max. Absolute Min.	Means.	Absolute Range.
1,600 Ft. Cleared Site.	North...	Mean Max.......	6 in.	72·14	77·25	79·78	81·23	73·72	76·30	66·77	65·55	68·13	63·80	66·59	71·17			
			20 ft.	70·77	75·77	77·01	77·83	74·04	76·40	66·67	66·97	67·47	65·92	66·63	70·46			
			40 ft.	68·52	74·18	74·84	75·55	71·55	73·66	64·14	65·60	66·74	63·95	64·51	67·64			
1,600 Ft. Cleared Site.	South...	Mean Max.......	6 in.	69·50	72·92	74·35	75·87	69·91	71·26	59·01	55·00	56·93	59·19	62·32	66·71			
			20 ft.	69·34	74·48	75·54	75·64	70·80	71·35	61·62	61·48	62·46	61·49	62·61	67·62			
			40 ft.	67·55	72·54	73·32	73·30	69·19	71·19	61·67	62·20	62·77	61·54	61·92	65·66			
	North...	Mean Max.......	6 in.	68·16	67·69	72·05	72·60	66·22	68·05	58·33	58·61	59·25	57·69	60·15	62·55			
			20 ft.	65·89	55·46	57·88	58·07	53·30	54·32	50·25	48:47	49–31	46·29	48·82	48·34			
			40 ft.	64·13	54·96	57·42	57·72	52·80	54·60	49·04	48·18	48·84	46·19	48·30	47·89			
	South...	Mean Min.......	6 in.	65·94	65·44	68·71	70·33	64·82	65·55	54·87	52·28	53·32	54·30	57·44	60·17			
			20 ft.	64·92	55·13	57·58	58·11	53·48	53·84	48·83	47·48	48·37	45·91	48·57	47·74			
			40 ft.	63·07	54·50	58·03	57·04	53·37	58·04	48·24	46·83	47·67	45·14	47·05	47·09			
	North...	Mean Temp......	6 in.	70·15	72·47	75·91	76·91	69·97	72·17	62·55	62·08	63·69	60·74	63·37	66·86		68·07	
			20 ft.	68·33	65·61	67·44	67·95	63·67	65·36	58·46	57·72	58·39	56·10	57·72	59·40		62·18	
			40 ft.	66·32	64·57	66·13	66·63	62·17	64·13	56·59	56·89	57·79	55·07	56·40	57·76		60·87	
	South...	Mean Temp......	6 in.	67·72	69·18	71·53	73·10	67·36	68·40	56·94	53·64	55·12	56·74	59·88	63·44		63·58	
			20 ft.	67·13	64·80	66·56	66·87	62·14	62·59	55·22	54·48	55·41	53·70	55·59	57·68		60·18	
			40 ft.	65·31	63·52	65·67	65·17	61·28	64·61	54·95	54·51	55·22	53·34	54·48	56·37		59·53	
	North...	Absolute Max....	6 in.	86·90	90·00	*104·50*	*100·50*	91·00	*100·50*	*87·50*	*80·00*	*81·00*	*83·00*	*89·00*	*89·00*	104·50 (Jan.)		
			20 ft.	80·75	91·00	94·75	94·75	89·50	96·75	83·50	80·50	79·25	77·50	87·00	88·00	96·75 (Apl.)		
			40 ft.	78·00	88·50	92·50	92·50	88·50	94·50	72·00	81·50	77·50	76·00	86·00	86·50	94·50 (Apl.)		
	South...	Absolute Max....	6 in.	80·50	91·50	*95·00*	*95·50*	88·50	*92·00*	*68·50*	*66·50*	*63·00*	*70·50*	*77·00*	*90·50*	95·50 (Feb.)		
			20 ft.	76·00	88·75	95·50	92·50	86·25	90·00	75·75	70·00	73·25	75·00	79·25	85·75	95·50 (Jan.)		
			40 ft.	74·50	87·50	94·00	91·00	85·50	91·50	79·00	76·00	75·00	74·50	82·00	85·00	94·00 (Jan.)		
	North...	Absolute Min....	6 in.	55·00	53·50	58·00	52·50	50·50	50·50	46·00	41·50	46·00	38·50	51·00	42·00	41·50 (June)		
			20 ft.	54·50	48·25	51·25	50·00	45·25	44·75	41·75	36·75	41·50	38·25	40·50	41·25	36·75 (June)		
			40 ft.	54·00	48·00	50·50	49·75	44·50	44·50	41·00	33·50	41·50	37·00	40·00	41·00	33·50 (June)		
	South...	Absolute Min....	6 in.	56·50	54·00	57·50	59·00	49·00	51·50	48·00	41·50	46·00	39·00	52·00	48·00	39·00 (Aug.)		
			20 ft.	54·75	49·25	49·75	49·75	41·75	48·00	39·25	41·00	39·25	38·00	40·00	40·25	38·00 (Aug.)		
			40 ft.	54·00	47·50	50·50	48·50	41·50	49·00	38·50	37·50	38·50	36·50	39·00	39·50	36·50 (Aug.)		
	North...	Mean Range.....	6 in.	3·98	9·56	7·73	8·63	7·50	8·25	8·44	6·94	8·88	6·11	6·44	8·62			63·00
			20 ft.	4·88	20·31	19·13	19·76	20·74	22·08	16·42	18·50	18·16	19·63	17·81	22·12			60·00
			40 ft.	4·39	19·22	17·42	17·83	18·75	19·06	15·10	17·42	17·90	17·76	16·21	19·75			61·00
	South...	Mean Range.....	6 in.	3·56	7·48	5·64	5·54	5·09	5·71	4·14	2·72	3·61	4·89	4·88	6·54			56·50
			20 ft.	4·42	19·35	18·96	17·53	17·32	17·51	12·79	14·00	14·09	15·58	14·04	19·88			57·50
			40 ft.	4·48	18·04	15·29	16·26	15·82	13·15	13·43	15·37	15·10	16·40	14·87	18·57			57·50

Italic figures denote Bergwind blowing

Table VIII.

AIR TEMPERATURES (THERMOMETERS IN STEVENSON'S SCREENS) UNDER FOREST CANOPY AND UNDER FULL EXPOSURE, DEEPWALLS.

Station.	Temperature °F.	Dec., 1924.		Jan., 1925.		Feb., 1925.		March, 1925.		April, 1925.		May, 1925.	
		Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.
Deepwalls. 1,600 feet, 2 adjacent sites north aspect	Mean Max.........	80·93	71·35	80·12	69·19	86·51	73·85	80·27	70·00	75·26	63·78	75·00	61·90
	Mean Min.........	57·46	57·63	55·98	55·54	59·37	59·10	58·11	58·00	52·20	51·78	50·67	51·11
	Mean Temp.......	69·19	64·49	68·05	62·36	72·94	66·47	69·19	64·00	63·73	57·78	62·83	56·50.
	Absolute Max......	*105·50*	*89·00*	*91·00*	*78·50*	*110·00*	*92·00*	98·00	78·00	*105·00*	*82·50*	*103·50*	*74·00*
	Absolute Min......	48·00	48·50	46·00	46·00	54·50	49·00	51·50	52·00	44·50	46·00	41·00	43·00

Station.	Temperature °F.	June, 1925.		July, 1925.		Aug., 1925.		Sep.. 1925.		Oct., 1925.		Nov., 1925.	
		Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.
Deepwalls. 1,600 feet, 2 adjacent sites north aspect	Mean Max.........	66·10	56·25	67·92	58·80	75·90	64·04	68·35	60·43	72·20	62·77	75·56	65·98
	Mean Min.........	46·51	47·66	48–76	48·43	48·32	48·83	49·30	49·46	48·77	49·01	51·28	51·46
	Mean Temp........	56·30	52·10	58·34	53·61	62·11	56·43	58·82	54·94	60·48	55·89	63·42	58–72
	Absolute Max......	*84·50*	*70·00*	*83·75*	*70·50*	*95·00*	*83·00*	*95·00*	*82·50*	*100·00*	*78·00*	97·00	79·00
	Absolute Min......	38·50	41·50	37·00	38·00	38·50	39·50	39·00	41·50	37·00	37·50	43·50	44·00

Italic figures denote Bergwind blowing.

Table IX.

SUPERFICIAL SOIL TEMPERATURES (THERMOMETERS IN WOODEN TUBES, BULBS ENCASED IN PARAWAX), DEEPWALLS.

Station.	Temperature °F.	Dec., 1924.		Jan., 1925.		Feb., 1925.		March, 1925.		April, 1925.		May, 1925.	
		1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.
North aspect, 1,600 feet fully exposed to insolation	Mean ¼ inch below surface	115·16	70·70	107·06	70·52	120·20	73·40	100·80	69·26	89·60	61·20	90·86	57·92
	Mean 6 inches below surface	68·50	70·75	68·29	71·37	71·77	74·77	69·00	71·25	63·09	65·55	60·39	62·04
Mean light intensity 6 inches above the soil = 1	Absolute Max. ¼ inch below surface	*170·60*	*82·70*	*163·40*	*84·50*	*170·60*	*87·80*	146·30	79·10	*147·50*	*78·26*	*120·50*	*66·56*
	Absolute Max. 6 inches below surface	*73·25*	*77·50*	*72·75*	*76·00*	*77·75*	*80·50*	74·50	79·00	*72·25*	*75·75*	*63·25*	*66·25*
North aspect, 1,600 feet under forest canopy	Mean ¼ inch below surface	69·21	61·80	64·87	62·66	67·73	65·44	65·87	63·65	60·80	58·10	59·11	56·09
	Mean 6 inches below surface	61·00	62·05	63·74	61·51	64·46	64·41	62–47	63·21	58·06	58·84	55·99	59·11
Mean light intensity 6 inches above the soil = 1/300	Absolute Max. ¼ inch below surafce	*79·75*	*76·50*	*74·00*	*70·25*	*77·50*	*73·50*	72·00	71·00	*76·25*	*70·00*	*67·50*	*62·25*
	Mean Max. 6 inches surface	64·00	65·00	69·50	66·25	80·50	72·00	66·00	66·25	64·00	66·00	59·00	60·00

Italic figures denote Bergwind blowing.

Table IX.—(Continued.)

SUPERFICIAL SOIL TEMPERATURES (THERMOMETERS IN WOODEN TUBES, BULBS ENCASED IN PARAWAX), DEEPWALLS.

Station.	Temperature °F.	June, 1925.		July, 1925.		Aug., 1925.		Sep., 1925.		Oct., 1925.		Nov., 1925.	
		1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.	1 p.m.	7 p.m.
North aspect, 1,600 feet fully exposed to insolation	Mean ¼ inch below surface	75·38	50·72	81·70	55·04	93·92	57·74	89·96	57·20	96·44	59·00	108·50	65·48
	Mean 6 inches below surface	54·89	55·96	55·88	58·04	59·31	62·54	60·05	62·15	62·84	64·57	66·12	68·31
Mean light intensity 6 inches above the soil = 1	Absolute Max. ¼ inch below surface	*102·20*	*64·40*	*106·10*	*76·40*	*115·20*	*70·70*	*144·50*	*75·20*	*149·00*	*73·40*	149·30	89·60
	Absolute Max. 6 inches below surface	*59·75*	*62·00*	*61·50*	*62·25*	*66·50*	*70·00*	*69·00*	*73·50*	*68·00*	*71·25*	72·75	74·50
North aspect, 1,600 feet under forest canopy	Mean ¼ inch below surface	52·83	51·54	54·00	52·66	59·01	55·16	55·89	54·21	59·53	54·63	63·31	58·30
	Mean 6 inches below surface	51·93	52·75	53·27	54·07	54·58	55·82	54·50	55·38	54·96	56·19	56·75	58·07
Mean light intensity 6 inches above the soil ≐ 1/300	Absolute Max. ¼ inch below surface	*61·50*	*60·00*	*64·00*	*61·00*	*72·25*	*64·75*	*72·75*	*68·00*	*76·00*	*64·25*	80·00	66·00
	Absolute Max. 6 inches below surface	56·25	57·50	57·25	58·50	60·50	62·50	60·00	62·00	59·00	61·75	60·25	62·50

Italic figures denote Bergwind blowing.

Table X.

SUPERFICIAL SOIL TEMPERATURE RUN FOR PORTION OF 30/1/25 AND 22/7/25, DEEPWALLS 1,600 FEET.

30/1/25	6 in. Below Surface.		¼ in. Below Surface.		Shade Max. 9 in. Above Surface.		Shade Min. 9 in. Above Surface.		Current Temp. 9 in. Above Soil.		Light.		Clouds.	Wind.	
	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.		Exposed.	Under Canopy.
Hour. 7 a.m.	66·25	60·25	62·00	61·50	63·50	63·00	57·50	57·50	62·50	62·75	Sun.	Shade ranging	0	0	0
9 a.m.	66·75	60·25	67·50	66·00	66·50	66·50	61·50	62·00	66·50	66·50	,,	from 1/200 to	0	0	0
11 a.m.	67·50	60·75	100·80	68·75	81·00	72·50	66·00	66·00	81·00	72·25	,,	1/300	0	0	0
1 p.m.	70·50	61·75	138·50	71·25	93·00	76·50	80·50	71·50	92·50	76·00	,,	Where full	0	0	0
3 p.m.	74·50	62·75	143·60	72·75	95·50	78·00	92·50	75·50	94·50	77·75	,,	light is 1	0	0	0
5 p.m.	72·50	62·50	109·80	73·00	95·50	78·50	82·00	75·50	82·00	78·00	,,		0	0	0
7 p.m.	74·50	64·25	83·70	70·25	83·00	79·00	74·00	72·00	74·25	72·50	,,		0	2 N.W.	1 N.W.
Means....	70·35	61·78	100·84	69·07	82·57	73·43	73·42	68·57	79·03	72·25					
22/7/25 7 a.m.	53·75	52·50	43·70	49·25	55·00	54·00	47·00	48·00	48·00	49·00	Sun.	Shade ranging	0	1 N.E.	0
9 a.m.	54·25	53·00	48·20	51·00	52·50	51·00	47·50	48·00	52·25	51·00	,,	from 1/200 to	0	2 N.E.	1 N.E. Canopy.
11 a.m.	54·50	53·25	55·80	54·00	59·00	56·50	52·00	50·50	59·00	56·25	,,	1/300	0	0	0
1 p.m.	56·00	53·50	96·80	56·00	69·00	60·50	59·50	56·00	68·75	60·25	,,	Where full	0	2 Berg	1 Berg
3 p.m.	59·75	54·00	93·20	57·75	73·00	62·50	68·50	59·50	68·00	61·50	Weak	exposure is 1	5	2 ,,	1 ,,
5 p.m.	61·00	54·50	68·00	61·00	69·50	62·00	60·00	58·00	60·00	58·25	Dull		10	1 S.E.	0
7 p.m.	60·00	55·00	57·20	55·00	60·00	58·50	57·50	56·00	58·75	56·00	,,		5	0	0
Means....	57·03	53·67	66·12	54·85	62·30	57·85	56·00	53·71	59·25	56·03					

Table XI.

DEEPER SOIL TEMPERATURES (THERMOMETERS IN STANDARD METAL TUBES: BULBS ENCASED IN PARAWAX), DEEPWALLS.

Station.	Soil Temperature. ° F.	Year.	January.			February.			March.			April.			May.			June.		
			8.30 a.m.	1.30 p.m.	7.30 p.m.	8.30 a.m.	1.30 p.m.	7.30 p.m.	8.30 a.m.	1.30 p.m.	7.30 p.m.	8.30 a.m.	1.30 p.m.	7.30 p.m.	8.30 a.m.	1.30 p.m.	7.30 p.m.	8.30 a.m.	1.30 p.m.	7.30 p.m.
Exposed Site, Small (20 × 20 yds.), Exploited Site in Forest, South Aspect, 1,600 ft., Deepwalls.	1 ft. Below Surface	1923	61·10	—	62·13	61·53	—	62·55	61·39	—	61·90	57·35	—	58·02	52·70	—	53·11	50·99	—	51·36
		1924	64·54	66·02	65·83	63·25	64·36	64·25	59·84	60·97	60·62	57·11	58·13	58·05	52·14	52·72	52·73	49·65	50·10	50·43
		1925	63·68	65·16	65·22	65·00	66·70	66·75	63·46	64·31	64·45	57·86	58·46	58·62	53·88	54·29	54·41	50·49	51·01	51·49
	2 ft. Below Surface	1923	60·62	—	60·16	60·84	—	60·74	60·93	—	60·93	58·36	—	58·04	54·42	—	54·45	52·55	—	52·54
		1924	64·09	64·27	64·09	63·27	63·35	63·17	60·72	61·10	60·78	58·05	58·21	58·21	54·28	54·38	54·25	51·60	51·72	51·75
		1925	63·25	63·41	63·07	64·17	64·25	64·31	63·37	63·56	63·65	59·10	59·27	59·31	55·32	54·46	55·48	52·40	52·62	52·75
Under Climax Forest, 60–100 ft. High, with Dense Trichocladus, South Aspect, 1,600 ft. Deepwalls.	1 ft. Below	1923	59·36	—	59·56	60·28	—	60·28	60·44	—	60·60	57·41	—	57·41	53·14	—	53·17	51·93	—	51·98
		1924	60·17	60·40	60·17	60·21	60·34	60·51	58·10	58·45	58·34	57·26	57·45	57·51	53·84	53·95	54·02	52·29	52·53	52·71
		1925	59·49	59·56	59·83	61·38	61·61	61·87	61·25	61·38	61·60	57·83	58·09	58·25	55·45	55·66	55·78	52·08	52·20	52·79
	2 ft. Below	1923	58·75	—	58·82	59·59	—	59·59	59·91	—	59·86	58·11	—	58·11	54·43	—	54·55	53·09	—	53·24
		1924	59·40	59·61	59·40	59·63	59·87	59·63	58·53	58·82	59·70	57·46	57·60	57·64	55·34	55·52	55·39	53·79	53·92	54·00
		1925	58·95	59·08	59·12	60·26	60·41	60·55	60·83	60·92	60·94	58·60	58·80	58·85	56·47	56·65	56·61	53·85	53·97	54·24
	4 ft. Below Surface	1923	58·01	—	58·10	58·84	—	58·84	59·21	—	59·15	58·34	—	58·34	55·36	—	55·55	53·93	—	54·08
		1924	58·57	58·75	58·57	59·04	59·21	59·06	58·54	58·77	58·68	57·48	57·71	57·63	56·09	56·24	56·13	54·61	54·76	54·72
		1925	58·24	58·31	58·33	59·26	59·88	59·40	60·19	60·21	60·13	58·85	58·93	58·88	56·90	57·06	57·04	54·89	54·89	55·12

Table XI.—(Continued).

DEEPER SOIL TEMPERATURES (THERMOMETERS IN STANDARD METAL TUBES; BULBS ENCASED IN PARAWAX), DEEPWALLS.

Station.	Soil Temperature. ° F.	Year.	July.			August.			September.			October.			November.			December.		
			8.30 a.m.	1.30 p.m.	7 p.m.	8.30 a.m.	1.30 p.m.	7 p.m.	8.30 a.m.	1.30 p.m.	7 p.m.	8.30 a.m.	1.30 p.m.	7 p.m.	8.30 a.m.	1.30 p.m.	7 p.m.	8.30 a.m.	1.30 p.m.	7 p.m.
Exposed Site, Small 20 × 20 yds.), Exploited Site in Forest, South Aspect, 1,600 ft., Deepwalls.	1 ft. Below Surface	1923	50·48	—	51·11	50·35	—	51·26	52·54	—	53·78	57·06	—	58·49	60·23	—	61·71	62·98	—	64·67
		1924	47·91	48·50	48·72	49·18	49·87	50·11	52·43	53·37	53·73	55·11	57·05	56·92	58·43	60·26	60·23	63·76	65·58	65·50
		1925	50·31	50·60	51·07	51·53	52·00	52·20	53·50	54·05	54·16	55·20	56·06	56·15	58·10	59·10	59·18	—	—	—
	2 ft. Below Surface	1923	51·93	—	52·02	51·43	—	51·54	53·02	—	53·23	56·67	—	56·80	59·64	—	59·70	62·43	—	62·45
		1924	49·66	49·78	49·79	50·66	50·72	50·86	53·03	52·94	53·30	55·37	55·50	55·45	58·15	58·24	58·18	62·23	62·44	62·42
		1925	51·57	51·62	51·98	52·19	52·50	52·50	54·04	54·19	54·11	55·60	55·73	55·69	58·13	58·08	58·07	—	—	—
Under Canopy, Climax Forest, 60–100 ft. High, with Dense Trichocladus, South Aspect, 1,600 ft., Deepwalls.	1 ft. Below Surface	1923	51·55	—	51·83	51·58	—	52·05	52·45	—	52·69	54·69	—	55·10	56·70	—	57·06	58·66	—	59·01
		1924	51·82	51·96	52·11	51·05	51·23	51·22	52·02	52·30	52·39	52·72	53·00	53·07	54·53	55·06	54·97	59·38	59·63	59·79
		1925	52·30	52·46	52·72	53·08	53·32	53·49	53·38	53·56	53·76	53·69	53·81	54·13	55·65	55·87	56·12	—	—	—
	2 ft. Below Surface	1923	52·55	—	52·82	52·27	—	52·50	52·95	—	53·06	54·45	—	54·63	56·22	—	56·38	57·98	—	57·97
		1924	52·03	53·10	53·19	52·24	52·35	52·43	52·62	52·73	52·83	53·11	53·29	53·25	54·48	54·69	54·62	58·08	58·30	58·15
		1925	53·47	53·56	53·79	53·60	53·81	53·89	53·88	54·05	54·02	54·09	54·21	54·24	55·59	55·70	55·71	—	—	—
	4 ft. Below Surface	1923	53·34	—	53·68	52·94	—	53·07	53·28	—	53·40	54·31	—	54·42	55·73	—	55·90	57·23	—	57·25
		1924	53·61	53·80	53·74	53·03	53·15	53·14	53·02	53·10	53·18	53·28	53·46	53·42	54·29	56·11	54·37	57·00	57·21	57·05
		1925	54·10	54·14	54·41	53·97	54·07	54·08	54·21	54·26	54·30	54·29	54·44	54·42	58·10	55·42	55·37	—	—	—

Table XII.

DEEPER SOIL TEMPERATURES (THERMOMETERS IN STANDARD METAL TUBES; BULBS ENCASED IN PARAWAX.)
EXAMPLES OF DIURNAL CHANGES UNDER FULL EXPOSURE AND UNDER FOREST CANOPY, FOR A TYPICAL WINTER DAY AND A TYPICAL SUMMER DAY: DEEPWALLS.

Hour.	Soil Temperature 12 in. Below Surface.				Soil Temperature 24 in. Below Surface.				Soil Temperature 48 in. Below Surface.	
	12th July, 1923.		16th January, 1924.		12th July, 1923.		16th January, 1924.		12th July, 1923.	16th January, 1924.
	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Under Canopy.	Under Canopy.
8 a.m.	50.00	51.10	63·00	59·50	52·00	53·00	62·25	59·00	53·75	58·50
9 a.m.	50.00	51.10	63·10	59·50	52·00	53·00	63·50	59·00	53·75	58.50
10 a.m.	50.10	51.10	63·75	59·75	52·00	53·00	63·60	59·10	53·60	58·60
11 a.m.	50.10	51.10	64·25	59·75	52·00	52·90	63·60	59·25	53·50	58·75
12 a.m.	50.10	51.10	64·75	59·75	52·00	52·90	63·75	59·25	53·50	58·75
1 p.m.	50.25	51.10	65·10	59·75	52·00	52·90	63·75	59·25	53·50	58·75
2 p.m.	50.25	51.10	66·00	59·75	52·00	52·75	63·75	59·50	53·50	58·75
3 p.m.	50.25	51.10	66·00	59·90	52·00	52·75	63·75	59·25	53·50	58·75
4 p.m.	50.25	51.10	66·00	59·90	52·00	52·75	63·75	59·25	53·50	58·75
5 p.m.	50.25	51.10	66·00	60·00	52·00	52·75	63·50	59·25	53·50	58·75
6 p.m.	50.25	51.10	66·00	60·00	52·00	52·90	63·50	59·25	53·50	58·75
7 p.m.	50.25	51.10	65·75	60·00	52·00	53·00	63·25	59·00	53·50	58·25
Means......	50.17	51.10	64.97	59.79	52.00	52.88	63.57	59.19	53.57	58.65
8 p.m.	50·25	51·25	65·50	60·00	52·00	53·00	63·25	59·00	53·75	58·25
9 p.m.	50·25	51·25	65·50	60·00	52·00	53·00	63·25	59·00	54·00	58·25
10 p.m.	50·25	51·25	65·50	60·25	52·00	53·00	63·50	59·25	54·00	58·50
11 p.m.	50·25	51·50	65·50	60·25	52·00	53·00	63·50	59·25	53·75	58·50
12 p.m.	50·25	51·50	65·25	60·25	52·00	53·00	63·75	59.25	53·75	58·75
1 a.m.	50·25	51·50	65·10	60·25	52·00	53·00	63·75	59·25	53·75	58·75
2 a.m.	50·10	51·50	65·00	60·25	52·00	52·75	63·75	59·25	53·50	58·75
3 a.m.	50·10	51·50	64·75	60·25	52·00	52·75	63·75	59·25	53·50	58·75
4 a.m.	50·10	51·50	64·75	60·25	52·00	52·75	63·75	59·25	53·50	58·75
5 a.m.	50·25	51·50	64·50	60·25	52·00	52·90	63·75	59·25	53·50	58·75
6 a.m.	50·25	51·50	64·25	60·25	52·00	52·90	63·75	59·25	53·50	58·75
7 a.m.	50·25	51·50	64·10	60·00	52·00	52·75	63·75	59·10	53·50	58·75
Means......	50·21	51·43	64·97	60·18	52·00	52·90	63·62	59·19	53·66	58·62

Table XIII.

AVERAGE POSSIBLE NUMBER OF HOURS DIRECT SUNLIGHT, BY WEEKS: DEEPWALLS.

Date.	Hours.	Date.	Hours.	Date.	Hours.
January 1	14·20	May 6	10·32	September 2	11·25
8	14·14	13	10 22	9	11·40
15	14·07	20	10·13	16	11·54
22	13·58	27	10·04	23	12·09
29	13·47			30	12·23
		Means	10·18		
Means	14·05			Means	11·54
February 5	13·34	June 3	9·58	October 7	12·37
12	13·21	10	9·54	14	12·52
19	13·07	17	9·51	21	13.06
26	12·53	24	9·51	28	13·20
Means	13·13	Means	9·53	Means	12·58
March 4	12·38	July 1	9·55	November 4	13·13
11	13·23	8	9·59	11	13·46
18	12·08	15	10·05	18	13·57
25	11·53	22	10·12	25	14·07
		29	10·22		
Means	12·15			Means	13·50
		Means	10·06		
April 1	11·39	August 7	10·33	December 2	14·14
8	11·25	12	10·45	9	14·18
15	11·11	19	10·58	16	14·21
22	10·58	26	11·11	23	14·22
29	10·44			30	14·20
		Means	10·51		
Means	11·11			Means	14·19

Table XIV (a).

HOURS OF DIRECT SUNLIGHT, DEEPWALLS, TOTAL PER MENSEM.

Year.	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
1923.....	250	198	220	160	212	217	184	249	230	195	217	271	2,603	216·9
1924.....	246	248	229	252	198	189	208	216	137	225	245	277	2,670	222·5
1925.....	264	262	174	207	214	163	194	215	148	211	261	231	2,544	212·0

Table XIV (b).

AVERAGE PER DIEM.

Year.	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1923............	8·0	7·0	7·1	5·3	6·8	7·2	5·9	8·0	7·6	6·2	7·2	8·7	
1924............	7·9	8·5	7·3	8·4	6·3	6·3	8·3	6·9	4·5	7·2	8·1	8·9	
1925............	8·5	9·3	5·6	6·9	6·9	5·4	6·2	6·9	4·9	6·8	8·7	8·5	
	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	h. m.
Average: Actual..	8·6	8·12	6·30	6·48	6·36	6·18	6·48	7·12	5·36	6·42	8·0	8·42	= 7·8
													h. m.
,, Possible	14·05	13·13	12·15	11·11	10·18	9·53	10·06	10·51	11·54	12·58	13·50	14·19	=12·4

Table XV.

COMPARISON OF DURATION OF DIRECT SUNLIGHT FOR SEVERAL CENTRES.

Centre.	Percentage of Total Possible Hours per Year.	Average Number of Hours of Sunshine per Diem.
	%	
Kimberley....................................	78	9·41
Johannesburg....................................	73	8·70
Capetown....................................	66	7·51
Knysna (Deepwalls)....................................	59	7·13
Baltimore....................................	58	7·10
London....................................	29	3·80

Table XVI.

RATIO OF DIRECT : DIFFUSED LIGHT.

Station.	Date.	Hour.	Ratio.		
			Intensity : Total.	Intensity : Direct.	Intensity : Diffused.
Deepwalls..................	21/12/23	Noon	5	4	1
	21/3/24	,,	5	4	1
	21/6/24	,,	5	4	1

Table XVII (a).

CONDITION OF THE SKY: DEEPWALLS 1,725 FEET (0 = CLOUDLESS SKY; 10 = ENTIRELY CLOUDED SKY).

	June, 1925.	July, 1925.	Aug., 1925.	Sept., 1925.	Oct., 1925.	Nov., 1925.	Dec., 1925.	Jan., 1926.	Feb., 1926.	Mar., 1926.	Apl., 1926.	May., 1926.	For the Year (Approx.
8 a.m..........	6	5	4	7	5	5	5	4	5	4	5	6	5·0
1 p.m..........	4	4	3	5	5	5	5	5	5	5	4	5	5·0
7 p.m..........	4	7	4	7	7	6	6	6	6	6	5	5	6·0

Table XVII (b).

COMPARISON OF DEGREE OF CLOUDINESS FOR SEVERAL CENTRES IN CAPE PROVINCE AND NATAL.

Centre.	Latitude S.	Longitude E.	Degree of Cloudiness.
*Wellington....................	33° 38′	19° 0′	3·8
*Mossel Bay....................	34° 11′	22° 9′	4·2
Deepwalls......................	33° 55′	23° 10′	5·3
*Kingwilliamstown..............	32° 51′	27° 22′	4·1
†Coastbelt, Natal..............	30° (Approx.)	31° (Approx.)	4·7

* Dove K. (1888 : 55).   † Bews, J. W. (1920 : 374).

Table XVIII.

EXAMPLES OF PHOTOMETRIC READINGS TAKEN IN THE FORESTS PER CLEMENTS'S STOPWATCH PHOTOMETER.

Date.	Time.	Condition of the Sky (0 : Cloudless).	Position of the Photometer	Characteristics of the Locality.	Value Compared with the Standard.	Standard.
22/1/24	9 a.m. 12 noon 3 p.m.	0	6 inches from soil, under the dense Trichocladus	High Forest with *Podocarpus Thunbergii* and *Olea laurifolia* dominant; dense stocking of smaller trees and of the layer societies of *Trichocladus crinitus*. Northern aspect: slope 10°, elevation 1,600 feet	1/300 1/500 1/250	Standard tints, noon. 21/1/24.
22/1/24	9 a.m. 12 noon 3 p.m.	0	20 feet above the soil, among the crowns of the trees (ladder erected)	High Forest with *Podocarpus Thunbergii* and *Olea laurifolia* dominant; dense stocking of smaller trees and of the layer societies of *Trichocladus crinitus*. Northern aspect: slope 10°, elevation 1,600 feet.	1/100 1/125 1/50	Standard tints, noon. 21/1/24.
22/1/24	9 a.m. 12 noon 3 p.m.	0	40 feet above the soil, among the crowns of the taller trees (ladder erected)	High Forest with *Podocarpus Thunbergii* and *Olea laurifolia* dominant; dense stocking of smaller trees and of the layer societies of *Trichocladus crinitus*. Northern apsect: slope 10°, elevation 1,600 feet	1/50 1/25 2/25	Standard tints, noon, 21/1/24.
9/10/25	3 p.m.	0	12 inches from soil	High Forest with *Podocarpus* spp., *Olea laurifolia* dominant, and with dense layer-society of *Hemitelia capensis* 8 to 12 feet in height. Southern aspect: slope 5°, elevation 1,500 feet	1/1000	Full exposure 2.45 p.m., 9/10/25.
6/11/25	12.10 p.m.	0	5 feet from soil	*Virgilia capensis* consocies 25 to 30 feet high, with scattered shrubs to 7 feet, and dense, small-stage natural regeneration of *Myrsine melanophleos*. Aspect flat; elevation 700 feet	1/5	Full exposure, 12 noon, 6/11/25.
6/11/25	12.15 p.m.	0	5 feet from soil	Small exploited site (focus-spot) in the Forest—20 by 20 yards. Aspect flat; elevation 700 feet	3/4	Full exposure, 12 noon, 6/11/25.
7/2/25	11.45 a.m.	0	6 inches from soil	Dense consocies of 5 year old *Clutia pulchella*, 8 to 10 feet high. Elevation 1,500 feet; aspect flat	1/300	Full exposure, 12 noon, 7/2/25.
29/7/25	12.5 p.m.	0	12 inches from soil	Tall Macchia (*Berzelia intermedia, Erica canaliculata, E. speciosa, Metalasia, Polygala myrtifolia*, etc.), 10 to 15 feet high. Aspect flat; elevation 700 feet	1/300	Full exposure, 12 noon, 29/7/25.
29/7/25	12.15 p.m.	0	12 inches from soil	Tall Macchia: *Berzelia intermedia* consocies.	1/120	Full exposure, 12 noon, 29/7/25.
17/2/26	2.30 p.m.	0	(1) Immediately above the *Plectranthus* (2) on soil under the *Plectranthus*	Luxuriant *Plectranthus fruticosus* consocies on a clear-felled site in Forest, Harkerville; 1½ years after felling	(1) 1 (2) 1/360	Full exposure, 2 p.m., 17/2/26.
17/2/26	2.45 p.m.	0	(1) Immediately above the *Helichrysum* (2) on soil under the *Helichrysum*	Luxuriant *Helichrysum petiolatum* consocies on a clear-felled site in Forest, Harkerville; 1½ years after felling	(1) 1 (2) 1/300	Full exposure, 2 p.m., 17/2/26.
17/2/26	2.5 p.m.	0	(1) Immediately above the *Aspidium* (2) on soil under the *Aspidium*	Heavily exploited Forest, Harkerville, 1½ years after felling. Under open canopy of *Podocarpus, Olea, Apodytes, Ocotea*. On ground dense layers of *Aspidium capense* 3 to 5 feet high	(1) 4/5 (2) 1/180	Full exposure, 2 p.m., 17/2/26.

Note to Tables XIX, XX, and XX(a).

Vapour Pressure.

The pressure in millibars of the aqueous vapour *actually* in the air.

Saturation Deficit.

The *lack* of vapour pressure, that is, the difference between the *actual* vapour pressure and that amount which the air would contain at the current temperature were the space saturated with aqueous vapour. It is the difference between the vapour pressure for the current temperature (dry bulb) and the vapour pressure for the temperature of the current dew-point. Without reference to temperature, the saturation deficit gives a measure of the dryness of the air. It is a distinctly more useful means of expression than is the relative humidity concept.

Relative Humidity.

The ratio, expressed as a percentage, of the *actual* aqueous vapour and that which would be present were the space saturated at the current temperature of the air.

Millibar.

The *millibar* is the 1/1000th part of a *bar* (the meteorological unit of atmospheric pressure in the C.G.S. system), and is equivalent to 1,000 dynes per square metre, or to the pressure of 0·0295306 inches of mercury at 32° F., in lat. 45. The *millibar* has been in use in the British Meteorological Office since 1st May, 1914.

Table XIX.

VAPOUR PRESSURE,* SATURATION DEFICIT† AND RELATIVE HUMIDITY‡ DATA (FROM 8.30 A.M. READINGS OF DRY AND WET BULB THERMOMETERS IN STEVENSON'S SCREENS 4 FEET ABOVE GROUND).

Station and Remarks.	Humidity.	Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Mean.
Deepwalls (1,725 ft.), De Vlugt Plateau	Mean Vapour Pressure (Millibars)	1923	—	16·4	15·4	11·6	8·9	8·3	7·5	8·0	10·5	12·4	14·2	15·4	11·6
		1924	15·9	15·7	13·8	12·6	8·9	8·0	7·2	8·2	10·6	10·9	13·0	16·5	11·7
		1925	16·0	18·1	17·6	12·0	9·9	8·2	8·6	9·6	10·9	11·9	12·9	14·7	12·5
	Mean Saturation Deficit (Millibars)	1923	—	4·0	4·7	5·9	5·5	5·2	4·2	6·6	4·5	5·0	4·1	4·8	4·9
		1924	5·5	5·3	4·0	6·0	5·5	6·3	6·9	4·5	3·2	5·0	3·5	6·0	5·1
		1925	4·6	7·3	3·7	6·1	6·0	4·6	4·5	6·7	3·7	4·0	5·3	5·0	5·1
	Mean Relative Humidity (Percentage)	1923	—	85·1	77·6	74·3	64·0	66·5	68·1	59·3	78·6	76·1	79·0	79·0	73·4
		1924	72·0	79·0	80·5	74·4	65·9	62·7	57·2	70·0	80·0	71·1	75·9	76·7	72·1
		1925	78·7	78·0	85·9	72·2	67·1	68·7	70·6	63·3	81·6	77·2	72·3	76·6	74·3
	Mean Temperature of the Dry Bulb, at 8.30 a.m. °F.	1923	—	63·45	63·42	58·83	54·29	52·09	51·53	54·60	53·37	58·85	60·83	63·09	57·66
		1924	65·70	64·60	59·50	60·60	54·08	53·47	53·38	51·30	52·96	56·60	57·92	66·39	58·04
		1925	64·29	68·16	64·77	59·94	56·70	51·15	51·39	56·41	54·10	56·72	60·49	62·70	58·90
Belvidere (Sealevel), on Estuary of the Knysna River	Mean Vapour Pressure (Millibars)	1923	18·0	19·2	18·2	14·8	11·6	10·8	10·8	10·5	12·9	15·3	16·5	18·1	14·7
		1924	18·7	18·2	15·6	14·9	11·6	10·6	9·9	11·2	13·4	14·0	15·8	19·8	14·4
		1925	18·6	20·4	19·0	14·8	12·1	10·3	10·8	12·4	13·2	14·1	15·2	16·8	14·8
	Mean Saturation Deficit (Millibars)	1923	6·3	5·2	4·7	3·4	2·8	1·8	1·9	2·4	2·7	4·8	6·5	6·6	4·0
		1924	6·4	5·9	3·4	3·7	1·6	2·4	1·7	1·6	2·0	4·1	4·5	5·5	3·5
		1925	6·0	5·6	3·5	2·7	2·1	2·3	1·9	1·4	3·7	4·7	6·9	5·8	3·8
	Mean Relative Humidity (Percentage)	1923	75·7	78·7	79·9	82·5	82·8	88·2	85·6	84·4	83·0	77·9	72·1	74·1	80·4
		1924	74·3	76·0	82·3	83·7	88·5	84·1	86·5	87·6	87·0	74·4	77·7	76·8	81·5
		1925	75·8	79·5	86·1	84·9	85·7	84·3	85·8	89·5	80·5	75·6	68·7	75·0	80·9
	Mean Temperature of the Dry Bulb, at 8.30 a.m. °F.	1923	68·90	69·30	67·50	60·69	54·20	51·00	50·30	51·00	56·78	63·56	67·70	69·63	60·88
		1924	70·60	69·00	62·26	60·96	52·10	51·00	48·26	50·64	56·10	60·08	63·94	70·85	59·64
		1925	69·40	71·00	66·70	59·20	54·00	50·73	50·90	53·15	58·56	61·48	66·52	67·13	60·73

*, †, ‡, *vide* these terms in Note to Tables XIX, XX, and XX (a). p. 74.

Table XIX.—(Continued).

VAPOUR PRESSURE,* SATURATION DEFICIT† AND RELATIVE HUMIDITY‡ DATA (FROM 8.30 A.M. READINGS OF DRY AND WET BULB THERMOMETERS IN STEVENSON'S SCREENS 4 FEET ABOVE GROUND).

Station and Remarks.	Humidity.	Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Mean.
Kaffir-Kop (1,180 ft.), Uplands Plateau	Mean Vapour Pressure (Millibars)	1924	17·2	16·0	14·2	12·1	9·5	8·6	8·9	9·3	12·0	11·1	13·1	17·0	12·4
	Mean Saturation Deficit (Millibars)	1924	5·6	5·0	4·6	7·8	6·5	6·5	7·7	5·0	2·6	4·7	4·9	5·8	5·5
	Mean Relative Humidity (Percentage)	1924	77·5	78·1	77·5	69·8	63·3	62·1	57·6	70·0	82·0	70·6	73·0	78·0	71·6
	Mean Temperature of the Dry Bulb at 8.30 a.m. °F	1924	66·90	64·90	61·30	62·30	56·80	54·80	57·80	53·70	54·70	57·30	60·60	66·60	59·80
Harkerville (650 ft.), Uplands Plateau	Mean Vapour Pressure (Millibars)	1925	—	—	—	—	—	—	—	—	—	14·0	13·9	15·4	14·4
		1926	18·2	17·2	17·0	15·6	13·2	11·5	10·7	10·0	11·2	—	—	—	13·8
	Mean Saturation Deficit (Millibars)	1925	—	—	—	—	—	—	—	—	—	3·2	5·5	5·1	4·6
		1926	6·0	4·9	3·1	2·5	2·9	3·5	2·1	2·7	3·8	—	—	—	3·5
	Mean Relative Humidity (Percentage)	1925	—	—	—	—	—	—	—	—	—	81·5	72·0	75·9	76·4
		1926	75·8	78·6	84·1	86·4	82·3	81·3	84·7	82·5	79·1	—	—	—	81·6
	Mean Temperature of the Dry Bulb, at 8.30 a.m. °F	1925	—	—	—	—	—	—	—	—	—	58·6	62·5	64·3	61·8
		1926	69·0	66·4	64·2	61·0	56·6	55·1	50·7	52·4	55·2	—	—	—	58·9

*, †, ‡, *vide* these terms in Note to Tables XIX, XX, and XXa. p. 74.

Table XX.

VAPOUR PRESSURE, SATURATION DEFICIT, AND RELATIVE HUMIDITY DATA (FROM 1 P.M. READINGS OF DRY AND WET BULB THERMOMETERS IN STEVENSON'S SCREENS 4 FEET ABOVE GROUND) ON TWO ADJACENT SITES: THE ONE FULLY EXPOSED TO INSOLATION THROUGH REMOVAL OF THE FOREST CANOPY, THE OTHER UNDER FOREST CANOPY.

Station.	Humidity.	December, 1924.		January, 1925.		February, 1925.		March, 1925.		April, 1925.		May, 1925.		June, 1925.	
		Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.
Deepwalls (1,600 ft.), Aspect North	Mean Vapour Pressure (Millibars)	19·4	19·6	19·7	18·1	21·3	21·4	20·5	20·0	16·4	15·6	14·6	13·6	12·2	11·6
	Mean Saturation Deficit (Millibars)	14·4	3·6	10·9	4·1	18·9	5·6	11·3	2·9	11·5	4·0	13·0	4·9	7·0	3·4
	Mean Relative Humidity (Percentage)	65·4	81·3	69·3	82·5	60·2	80·0	71·4	88·8	69·0	83·4	59·7	76·2	68·3	81·7
	Mean Temperature of the Dry Bulb, at 1 p.m. °F	77·19	68·46	74·73	66·58	82·42	71·54	75·42	67·07	70·56	62·30	71·40	60·91	61·60	54·79

Table XX.—(Continued.)

Station.	Humidity.	July, 1925.		August, 1925.		September, 1925.		October, 1925.		November, 1925.		Annual Mean.	
		Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex-posed.	Under Canopy.	Ex. posed.	Under Canopy.
Deepwalls (1,600 ft.), Aspect North	Mean Vapour Pressure (Millibars)	12·3	11·7	14·5	13·5	13·8	13·1	15·5	14·0	16·1	15·2	16·3	15·5
	Mean Saturation Deficit (Millibars)	9·1	5·1	12·3	5·3	8·2	3·7	9·0	3·7	13·1	5·3	11·5	4·3
	Mean Relative Humidity (Percentage)	62·1	71·7	62·0	75·6	71·3	83·5	68·8	81·6	61·8	76·2	65·5	80·2
	Mean Temperature of the Dry Bulb at 1 p.m. °F	64·33	56·86	70·11	61·08	64·63	57·96	67·54	59·64	73·21	63·84	71·9	62·58

∞ *Table XX (a)*

OCCURRENCES OF RELATIVE HUMIDITIES LOWER THAN 40 PER CENT. FOR THE STATIONS DEALT WITH IN TABLES XIX AND XX. RELATIVE HUMIDITIES OCCURRING ON DAYS OF "BERGWINDS" BEING IN ITALIC FIGURES.

Station.	Year.	Hour.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Deepwalls (1,725 ft.)	1923	8.30 a.m.	—	38	31·5, 32	*18*, *13*, *24*	33, *38*;, *39*. *34*, 38, *30·5*, *20·5*	*39*, *25·5*, *23*, *32*, 32·5	*28·5*, 20, 30, *27·5*, 33·5	36, 22·5, *19*, *13*, 37, *13*, 28, 36, 37, *14*	*19*, *15*, 26·5	32·5, 15, 17·5	—	—	39
	1924		—	38, *37*	*38*, *30·5*	34, 38, *25*, *26*	27·5, 30, *23*, 33, 32·5, 37	*37*, *26*, *26·5*, *19·2*, 37, 17, *25*, 29, 20	*23*, *24*, 11, 30, 25, *19*, *18*, 17, *38·5*, *37·7*	32, *16*, 30, 28	*18·5*, *23*, 36·5	38·5, 31	—	38·5, 39	44
	1925		—	*37*, 25	—	36·5, 31·5, *27*	34·5, 32·5, 31, *38*, *33*	17·5, 36·5, 38·5, 29, 28·5	39, 33, 25, 34·5	*27*, 37, *31*, 20·5, *34*, 34, 22, *38*, *15*, *27*	*25·5*, *30·5*, *28*	—	—	—	32
	Totals		0	5	4	10	18	19	19	24	9	5	0	2	115
Belvidere	1923	8.30 a.m.	—	—	—	—	*39·5*	—	—	—	—	—	—	—	1
	1924		—	—	—	*32·5*	—	*27·5*	*31·5*	—	—	—	—	—	3
	1925		—	—	—	—	*27·0*	—	—	—	*37·5*	—	—	—	2
	Totals		—	—	—	1	2	1	1	—	1	—	—	—	6
Kaffirkop	1924	8.30 a.m.	*38·5*	34	*36·5*, *38*	*27·5*, *16*, *21*, *16·5*	*31·5*, *29*, 38·5, *23*, 33, *25·5*, *21*	*26·5*, *30*, *15·5*, *15*, *26*, *26·2*, *20*	*21·5*, *25·5*, *35·5*, *25*, *25*, *25·5*, *14·5*, *15*, *30·7*	*16*, *22*	*33·5*	*37*, *34*	—	—	36
	Totals		1	1	2	4	7	7	9	2	1	2	0	0	36
Harkerville	1925	8.30 a.m.	—	—	—	—	—	—	—	—	—	*32·0*	—	—	1
	1926		*20*	—	—	—	—	*32*	*38*	*25*, *25·5*	*31*, *20·5*	—	—	—	7
	Totals		1	—	—	—	—	1	1	2	2	1	—	—	8

Table XX (a).—(Continued.)

Station.	Year.	Hour.	Jan.		Feb.		March.		April.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
			Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.	Exposed.	Under Canopy.
Deepwalls, North Aspect (1,600 ft.)*	1924	1 p.m.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24·4 38·0 36·5 37·0 36·0 38·0	—	6	—
			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—		
	1925	1 p.m.	—	—	39·5 31 *19·7*	—	*35* 39 *31*	—	*25* *17·5* *25* *39*	*37*	·5 *27* 30·5 30·7 39 39 32 38·7	—	*36·5* *36·5* *35*	—	*33* *28* *30* *33*	—	*23* *30* *35* *35* *34* *33·5* *23* *20*	*32* *35·5*	*29* *29* *13*	*35*	36·5 *15·5* *34·5*	—	33 39·7 31·5 35	—	—	—	43	·4
	Totals		—	—	3	—	3	—	4	1	8	—	3	—	4	—	8	2	3	1	3	—	4	—	—	—	49	4

* *Period:* 1st December, 1924–30th November, 1925, only.

Table XXI.

COMPARISON OF RAINFALL MEANS FOR 15 CENTRES IN OR NEAR THE REGION.

Stations.	Long. E.	Lat. S.	Period.	Rainfall in Inches.	Number of Days.	Percentage of Summer Rainfall.	Percentage of Winter Rainfall.
Mossel Bay...........	22·09	34·11	1877–1915	17·31	90	47	53
George...............	22·29	33·57	1878–1915	34·36	125	57	43
Millwood.............	22·59	33·53	1887–1915	41·64	120	58	42
Buffelsnek............	23·10	33·53	1890–1915	47·69	124	55	45
Sourflats..............	23·00	33·57	1888–1915	34·68	115	56	44
Knysna...............	23·03	34·03	1880–1915	8·27	97	49	51
Concordia............	23·03	34·02	1891–1915	37·90	113	54	46
Harkerville............	23·12	34·03	1888–1915	37·92	115	51	49
Plettenberg Bay.......	23·22	34·04	1891–1915	26·33	77	47	53
Forest Hall...........	23·31	33·59	1890–1902	29·25	108	56	44
Lottering.............	23·41	33·56	1896–1915	42·35	105	54	46
Storms River.........	23·52	33·58	1883–1915	44·40	128	53	4
Wit Els Bosch........	24·09	34·00	1892–1915	44·99	106	52	48
Humansdorp..........	24·46	34·02	1878–1915	26·88	92	50	50
Uniondale.............	23·09	33·29	1878–1915	13·50	49	45	55

Table XXII.

MONTHLY RAINFALL DATA FOR FIVE STATIONS WITHIN THE KNYSNA REGION.

Altitude and Position.	Station.	Rainfall.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
10 ft., on Banks of Estuary, Knysna, 2 Miles from Sea (Air Line)	Belvidere Lat.: 34·04 S. Long.: 23·00 E.	Total in Inches	1923	3·92	1·38	2·03	4·77	2·87	3·72	1·35	2·96	1·92	2·47	3·36	1·54	32·29
			1924	2·47	1·95	1·69	2·21	2·62	2·53	1·06	4·56	3·13	2·86	3·42	1·47	29·97
			1925	2·24	1·29	1·76	1·62	1·03	3·84	1·01	2·17	8·15	3·45	2·70	3·59	32·85
		Number of Days with Rainfall 0·01 Inch and over	1923	16	9	11	14	11	11	10	9	9	8	13	8	129
			1924	7	5	11	8	9	13	9	16	12	10	14	13	127
			1925	12	8	13	11	8	14	12	12	15	12	10	14	141
		Greatest Amount in 24 Hours	1923	1·57	0·34	1·03	1·02	1·26	1·44	0·51	1·19	1·06	1·45	1·57	0·37	—
			1924	1·15	0·71	0·70	0·88	1·19	0·36	0·31	1·57	1·56	1·23	0·95	0·44	—
			1925	0·66	0·64	0·46	0·45	0·24	1·59	0·30	1·12	3·60	1·03	0·69	0·86	—
1,180 ft., on Upper Portion of Uplands or 1st Plateau, on edge of Main Forest, 5½ Miles from Sea (Air Line)	Kaffirkop	Total in Inches	1923	3·27	1·61	2·10	4·34	3·28	2·44	1·00	2·86	2·45	3·88	3·97	1·74	32·94
			1924	2·35	1·54	2·42	2·21	2·19	3·22	0·62	4·44	3·81	2·27	3·13	1·95	30·15
			1925	1·91	2·84	2·42	2·86	1·58	3·58	1·58	2·70	6·59	5·16	3·21	3·35	37·78
		Number of Days with Rainfall 0·01 Inch and over	1923	16	9	11	13	10	8	3	7	7	5	13	7	109
			1924	7	5	10	5	10	10	6	9	12	8	9	12	103
			1925	8	8	7	10	6	10	5	9	15	11	8	10	107
		Greatest Amount in 24 Hours	1923	0·91	0·31	1·35	0·91	1·35	1·02	0·56	1·35	0·91	1·65	1·65	0·53	—
			1924	1·05	0·65	0·51	0·80	0·79	1·01	0·22	1·32	1·23	1·03	1·00	0·60	—
			1925	0·49	1·35	0·60	1·21	0·60	1·60	0·64	1·20	2·51	1·72	1·00	0·60	—

Table XXII.—(Continued).

MONTHLY RAINFALL DATA FOR FIVE STATIONS WITHIN THE KNYSNA REGION.

Altitude and Position.	Station.	Rainfall.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1,725 ft., 9 Miles from Sea (Air Line), Plateau in Main Forest.	Deepwalls Lat.: 33·90 S. Long.: 23·16 E. (Approx.)	Total in Inches	1923	5·77	2·71	2·76	5·12	3·64	2·91	1·24	2·93	3·05	4·11	5·65	3·51	43·40
			1924	3·64	3·57	3·02	2·91	2·96	2·41	0·61	5·76	5·90	4·77	4·38	4·27	44·20
			1925	3·17	2·83	4·11	3·83	1·95	3·96	2·66	3·59	9·04	6·03	3·91	4·88	49·96
		Number of Days with Rainfall 0·01 Inch and over	1923	18	13	15	17	10	11	9	8	11	13	16	11	152
			1924	11	8	14	12	10	10	7	12	16	13	16	15	144
			1925	12	10	15	12	8	10	7	8	16	14	11	18	141
		Greatest Amount in 24 Hours	1923	2·07	0·88	1·32	0·96	1·65	1·20	0·45	0·88	1·05	1·62	1·93	0·95	—
			1924	1·13	1·14	1·18	0·76	1·05	0·61	0·25	1·58	2·35	1·38	1·18	1·01	—
			1925	0·74	1·00	1·34	1·04	0·97	1·68	1·75	1·72	3·40	1·69	1·28	1·02	—
1,500 ft., 12 Miles from Sea (Air Line)	Millwood Lat.: 33·53 S. Long.: 22·59 E.	Total in Inches	1923	5·01	2·64	2·98	5·24	2·31	2·31	0·75	2·70	1·96	3·61	5·67	2·71	37·89
			1924	3·79	2·96	1·95	3·41	2·79	2·38	0·58	4·77	5·27	2·89	4·96	5·82	41·57
			1925	3·31	2·14	4·11	3·51	2·38	3·07	1·12	4·40	10·95	4·39	3·30	4·13	46·81
		Number of Days with Rainfall 0·01 Inch and over	1923	14	10	12	16	8	7	5	9	10	9	11	12	123
			1924	8	7	9	10	10	8	5	13	12	11	14	12	119
			1925	11	9	15	12	9	13	8	8	18	15	10	17	145
		Greatest Amount in 24 Hours	1923	1·30	0·56	1·32	0·95	2·50	1·00	0·36	0·86	0·79	1·40	2·03	0·60	—
			1924	1·01	1·07	0·76	0·85	1·30	0·51	0·19	1·20	2·70	0·70	0·95	1·22	—
			1925	0·91	0·88	1·40	1·03	0·97	1·49	0·67	1·77	4·86	1·30	1·03	0·68	—

Table XXII.—(Continued).

MONTHLY RAINFALL DATA FOR FIVE STATIONS WITHIN THE KNYSNA REGION.

Altitude and Position.	Station.	Rainfall.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
580 ft., 3 Miles from Sea (Air Line), on the Plateau below the Mountains	Storms River Lat.: 33·58 S. Long.: 23·52 E.	Total in Inches	1923	5·71	2·00	1·92	3·99	3·08	4·56	1·66	1·81	2·36	2·93	3·41	3·10	36·53
			1924	3·63	1·49	1·86	1·40	2·56	3·24	1·09	6·65	4·27	3·36	4·28	2·81	36·64
			1925	1·59	1·12	2·91	4·46	2·42	9·00	1·97	3·45	5·49	5·18	3·24	4·81	45·64
		Number of Days with Rainfall 0·01 Inch and over	1923	17	6	12	18	10	6	7	7	9	10	14	9	125
			1924	10	6	10	8	11	11	6	8	12	9	10	10	111
			1925	9	8	8	8	9	9	11	8	13	13	9	12	117
		Greatest Amount in 24 Hours	1923	2·12	0·77	0·72	1·20	0·98	2·30	0·50	0·52	0·55	1·55	1·07	0·58	—
			1924	1·06	0·65	0·73	0·78	1·34	0·91	0·46	2·10	1·50	1·35	1·42	0·90	—
			1925	0·41	0·66	0·98	2·41	0·97	3·71	0·60	1·74	2·37	1·77	1·20	2·20	—

Table XXIII.

COMPARISON OF CATCHES BY OPEN AND VEGETATION-SCREENED 5 INCH-DIAMETER RAIN-GAUGES (HEIGHT OF RIM 4 FT. ABOVE GROUND).

		June, 1925.	July, 1925.	Aug., 1925.	Sep., 1925.	Oct., 1925.	Nov., 1925.	Dec., 1925.	Jan., 1926.	Feb., 1926.	March, 1926.	April, 1926.	May, 1926.	Total for Year.	Percentages.
Control....... (Open)	Rainfall...........	3·96	2·66	3·59	9·04	6·03	3·91	4·88	3·37	*3·41*	5·62	3·43	2·12	52·02	% 100
	Number of days with 0·01 in. or more	10	7	8	16	14	11	18	11	18	16	10	8	147	—
Condensation.. (Vegetation screened)	Rainfall...........	7·95	2·73	6·81	19·49	12·46	7·20	7·95	6·34	*3·32*	10·54	6·60	3·17	94·56	181·7
	Number of days with with 0·01 in. or more	10	8	7	14	13	11	18	9	12	16	10	8	136	—
Rain types...	Fine drizzle and mist with wind	9	1	8	6	12	11	18	10	10	14	10	8	117	79
	Normal showers....	—	2	—	8	2	—	—	—	7	1	—	—	20	13
	Heavy downpour...	1	5	—	2	—	—	—	1	1	1	—	—	11	8

Italic figures indicate exceptional instance of catch of control greater than catch of condensation gauge.

Table XXIV.

RAINFALL DATA GAUGE UNDER FOREST CANOPY, FEBRUARY, 1923–JANUARY, 1925.

Elevation and Position.	Station.	Rainfall.	Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total Forest.	Total Exposed Control.
1,500 feet forest gauge (under high canopy)	Deepwalls..	Total in inches.....	1923	*	1·54	2·42	4·48	3·24	3·49	0·89	2·21	2·02	4·27	5·25	3·03	32·84	37·63
			1924	2·54	2·34	2·71	1·88	2·03	1·48	0·10	3·80	4·73	3·45	2·95	2·84	30·85	44·20
			1925	2·29	—	—	—	—	—	—	—	—	—	—	—	2·29	3·17
																65·98 Mean Percentage.	85·00
		Percentage of controi	1923	—	56·8	87·6	87·5	89·0	119·9	71·7	75·4	66·2	103·8	92·09	86·3	85·11	—
			1924	69·7	65·5	89·7	64·6	68·5	61·0	16·3	65·9	80·1	72·3	67·3	66·5	65·61	—
			1925	72·2	—	—	—	—	—	—	—	—	—	—	—	72·20	—
																74·30	
																Total Forest.	Total Exposed Control.
		No. of days with rainfall 0·01 inch and over	1923	—	8	10	15	9	7	6	7	10	10	15	11	108	134
			1924	10	5	12	8	9	7	5	13	14	9	13	10	115	144
			1925	9	—	—	—	—	—	—	—	—	—	—	—	9	12
																232	290
		Difference in No. of rainy days compared with base	1923	—	5	5	2	1	4	3	1	1	3	1	0	−26	—
			1924	1	3	2	4	1	3	2	1	2	4	3	5	−29	—
			1925	3	—	—	—	—	—	—	—	—	—	—	—	− 3	—
																−58 Less than the control.	
		Greatest amount in 24 hours forest	1923	—	0·57	1·78	1·07	2·10	1·12	0·45	0·90	0·82	2·27	2·60	0·90	—	—
			1924	1·05	0·84	0·93	0·69	0·94	0·45	0·04	0·58	2·40	1·23	0·77	0·93	—	—
			1925	0·74	—	—	—	—	—	—	—	—	—	—	—	—	—

* No reading available.

Table XXV.

Record of Falls of Snow on Barrier Range and Foothills, 1922–1926.

Year.	May.	June.	July.	August.	October.
1922.....	—	—	—	x Slight.	—
1923.....	—	—	x Slight.	—	—
1924.....	x Slight.	—	—	x Heavy.	—
1925.....	—	—	x Heavy.	x Heavy.	—
1926.....	—	—	x Very Heavy.*	x Very Heavy.†	2x Slight.

* On foothills as well.
† Three inches deep at Deepwalls, 1,725 feet remained 3 days in portions of forest adjacent; damage done to young trees.

Table XXVI.

Record of Hail Storms at Deepwalls, 1923–1926.

Station.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Remarks.
Deepwalls 1,725 feet	1923	—	—	x	—	x	—	—	—	—	—	—	—	2	Slight.
	1924	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1925	—	—	—	—	x	—	—	—	—	—	—	—	1	Slight.
	1926	—	—	—	—	x2	x	x4	x5	—	—	—	—	12	All slight.
Total....	—	—	—	—	—	—	—	—	—	—	—	—	—	15	

Table XXVII.

CLASSIFICATION OF WINDS AT {8.30 A.M. / 7 P.M.} BY DIRECTION DEEPWALLS 1,725 FEET, YEARS 1924 AND 1925.

Direction from.	Year.	Jan. 8.30 a.m.	Jan. 7 p.m.	Feb. 8.30 a.m.	Feb. 7 p.m.	March. 8.30 a.m.	March. 7 p.m.	April. 8.30 a.m.	April. 7 p.m.	May. 8.30 a.m.	May. 7 p.m.	June. 8.30 a.m.	June. 7 p.m.	July. 8.30 a.m.	July. 7 p.m.	Aug. 8.30 a.m.	Aug. 7 p.m.	Sep. 8.30 a.m.	Sep. 7 p.m.	Oct. 8.30 a.m.	Oct. 7 p.m.	Nov. 8.30 a.m.	Nov. 7 p.m.	Dec. 8.30 a.m.	Dec. 7 p.m.	Total. 8.30 a.m.	Total. 7 p.m.
N.	1924	—	—	—	1	—	—	—	—	1	1	—	—	1	1	3	—	1	—	—	—	—	—	—	—	6	3
	1925	—	—	—	—	—	—	—	—	—	—	3	1	3	—	—	—	—	—	1	—	—	—	—	—	7	1
NNW.	1924	—	—	—	—	—	—	—	—	—	—	2	—	—	—	2	—	1	—	1	—	—	—	—	—	6	—
	1925	1	—	1	—	—	—	—	—	4	—	10	—	8	1	3	—	—	—	—	—	—	—	—	—	27	1
NW.	1924	5	5	6	4	7	5	5	8	10	12	11	14	9	17	7	18	8	14	14	11	12	16	6	12	100	136
	1925	8	10	6	4	9	5	7	10	5	3	13	17	12	10	11	9	18	14	19	10	13	6	23	19	144	117
NE.	1924	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1925	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	2	—	3	1
E.	1924	—	—	—	—	—	—	—	—	—	—	—	—	3	2	—	—	—	—	—	—	—	—	—	—	3	2
	1925	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SE.	1924	6	9	7	8	8	10	2	10	1	3	1	2	3	1	3	2	7	9	6	4	6	7	5	9	55	74
	1925	7	11	6	18	8	8	6	5	3	2	—	—	1	4	5	4	6	5	6	11	9	4	5	5	62	77
W.	1924	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1925	—	3	—	—	—	—	—	—	1	—	1	2	1	4	—	—	—	—	1	—	—	—	—	—	4	9
SW.	1924	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—
	1925	—	—	—	—	—	—	1	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	1	—	3	2
Berg.	1924	1	—	2	—	2	—	5	2	1	—	6	—	6	1	3	1	2	—	1	—	—	—	1	—	30	4
	1925	—	1	1	—	2	2	4	—	2	2	—	2	—	5	9	2	4	2	1	2	—	—	—	—	23	18
		28	39	30	35	36	30	30	35	28	24	48	39	47	47	46	36	47	44	50	38	40	33	44	45	474	445

Table XXVIII.

CLASSIFICATION OF WINDS AT $\left\{ \begin{array}{l} \text{8.30 A.M.} \\ \text{7 P.M.} \end{array} \right\}$ BY FORCE (BEAUFORT SCALE) DEEPWALLS 1,725 FEET, YEARS 1924 AND 1925.

		Year.	Jan.		Feb.		March.		April.		May.		June.		July.		Aug.		Sep.		Oct.		Nov.		Dec.		Total.	Total.
			8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.30 a.m.	7 p.m.	8.50 a.m.	7 p.m.	8.30 a.m.	7 p.m.
1	1–3 Light air.	1924	12	11	10	7	11	11	5	11	7	8	10	7	11	1	10	3	9	2	13	3	11	9	8	10	117	83
		1925	8	8	5	5	13	5	8	11	7	4	14	7	11	9	7	6	10	5	10	7	8	9	14	10	115	86
2	4–7 Light breeze	1924	—	3	4	3	3	4	6	8	5	8	3	4	3	9	5	6	7	13	7	2	4	6	2	4	49	70
		1925	6	10	5	14	6	6	9	2	3	—	4	6	8	4	12	4	8	7	11	8	5	1	7	5	84	67
3	8–12 Gentle breeze	1924	—	1	—	2	3	1	—	1	1	—	2	2	2	8	1	6	3	5	2	6	3	5	3	7	20	44
		1925	1	4	4	3	—	3	—	—	3	2	4	7	4	8	7	2	6	8	4	4	6	—	5	7	44	48
4	13–18 Moderate breeze	1924	—	—	1	—	—	—	1	—	—	—	1	2	—	2	2	4	—	3	—	2	—	2	—	—	5	15
		1925	1	1	1	—	—	1	1	1	1	2	4	3	2	1	—	2	3	1	2	2	1	—	3	1	19	15
5	19–24 Fresh breeze	1924	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	—	—	—	—	1	—	1	—	—	2	3
		1925	—	1	—	—	—	—	—	1	—	—	1	1	2	2	2	1	1	—	1	2	2	—	—	—	9	8
3	25–31 Strong breeze	1924	—	—	—	—	—	—	—	—	1	—	—	—	—	2	—	1	—	—	—	—	—	—	—	—	1	3
		1925	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
7	32–38 Moderate gale	1924	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		1925	—	—	—	—	—	—	—	—	—	—	1(N)	—	1(N)	—	—	—	—	—	—	—	—	—	—	—	2	—
8	39–46 Fresh gale	1924	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1
		1925	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	47–54 Strong gale	1924	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
		1925	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			28	39	30	34	36	31	30	35	28	24	44	40	46	46	46	36	47	44	50	38	40	33	42	45	467	445

Table XXIX (a).

EVAPORATION MEANS AND ABSOLUTE MAXIMA, DEEPWALLS, JULY, 1925–JUNE, 1926.

Station Nature.	Evaporation.*	July, 1925.	August, 1925.	September, 1925.	October, 1925.	November, 1925.	December, 1925.	January, 1926.	February, 1926.	March, 1926.	April, 1926.	May, 1926.	June, 1926.	Grand Absolute Maximum in 24 Hours c.c.
Full lignt-intensity height above ground 12 inches full atmospheric conditions	Mean evaropation in 24 hours c.c.	10·679	14·669	11·039	8·259	10·736	8·910	11·339	8·725	7·788	10·290	10·389	11·135	
	Absolute maximum evaporation c.c.	33·312	56·148	58·547	26·250	29·154	27·951	22·007	22·781	24·292	46·738	32·765	28·900	= 58·547
	Weather at date of absolute maximum Total for 12 months = 3,595·699 c.c.	Still Warm Clear	Berg Wind Force 5 Hot, clear	Berg Wind Force 4 Hot, clear	N.W. Wind Force 2 Warm, clear	N.W. Wind Force 1 Warm, cloudy	Berg Wind Force 2 Warm, clear	N.W. Wind Force 3 Warm, clear	N.W. Wind Force 3 Warm, clear	Berg Wind Force 2 Warm, clear	Berg Wind Force 2–4 Hot, clear	Berg Wind Force 3 Warm, clear	Berg Wind Force 3 Warm, clear	Berg Wind. Force 4. Hot clear.
Table XXIX (b). Light intensity $\frac{1}{30}$ height above ground 12 inches	Mean evaporation in 24 hours c.c.	8·604	9·874	5·835	5·218	7·503	5·988	6·280	6·648	4·478	7·545	9·157	—	
	Absolute maximum evaporation c.c.	30·338	40·058	36·145	21·282	21·163	20·649	13·650	19·479	20·443	34·625	29·880	—	= 40·058
	Weather at date of absolute maximum Total for 11 months = 2,350·401 c.c.	Still Warm Clear	Berg Wind Force 5 Hot, clear	Berg Wind Force 4 Hot, clear	N.W. Wind Force 2 Warm, clear	N.W. Wind Force 1 Warm, cloudy	Berg Wind Force 2 Warm, clear	N.W. Wind Force 3 Warm, clear	N.W. Wind Force 3 Warm, clear	Berg Wind Force 2 Warm, clear	Berg Wind Force 2–4 Hot, clear	Berg Wind Force 3 Warm, clear	— — —	Berg Wind. Force 5. Hot clear.

* Livingston Atmometers (spherical) with Thone valves; standardized.

Table XXX.

INFLUENCE OF BERG WINDS UPON RATE OF EVAPORATION, DEEPWALLS, 1,725 FEET, *August*, 1925.

	Humidity.	Berg Winds.	Evaporation in Grammes.*
	%		
1...	31·00	Berg 2....................	31·096
2...	97·00		4·042
3...	99·50		3·779
4...	90·00		22·900
5...	38·00		26·029
6...	97·00		0·001
7...	89·50		18·264
8...	34·75	Berg 2....................	56·148
9...	30·00		7·132
10...	81·75		4·859
11...	97·00		0·001
12...	97·75		0·550
13...	81·00		7·969
14...	84·00		22·495
15...	38·00	Berg 2....................	29·420
16...	43·00	Berg 5....................	33·655
17...	82·00		10·915
18...	76·00		17·735
19...	84·50		13·413
20...	29·00	Berg 2....................	38·155
21...	76·00		7·950
22...	77·75		20·502
23...	36·00	Berg 3 night..............	36·100
24...	25·00	Berg 3....................	32·515
25...	97·25		1·835
26...	90·00		8·379
27...	82·25		7·116
28...	92·25		19·299
29...	30·00	Berg 5....................	29·746
30...	98·00		20·785
31...	58·00	Berg 1 (short duration).....	8·615
Sums	2,163·25	Total............	541·400
Mean	69·78	Mean........................	17·464
		Corrected mean (0·84 correction)........................	= 14·669

* Standardized Livingston Atmometer (spherical) with Thone non-absorbent valves.

Table XXXI.

Zoobiotic Associates.

Zoological Name.	Common Name.	Function and Remarks.
Ephydatia fluviatilis........	Fresh-water sponge.....	Occurs at the base of Phragmites and Typha, as a felt-like mass, especially in pools or slow-flowing streams; dies down in winter.
Helicidae—various..........	Snails.................	Frequent on boles and foliage of forest trees, but do slight harm.
Helix aspersa (exotic).......	Common snail..........	Locally abundant; does much harm to young trees in seedling stages.
Achatina zebra.............	Great snail............	Frequent, but does slight harm.
Allolobophora spp..........	Earthworms............	—
Lumbricus rubellus and other exotic Lumbricidae	Earthworms............	Throughout the region in upper soil layers, but density per acre varies directly with soil quality.
Acanthodrilidae.............	Earthworms............	The worms assist in aerating the soils.
Millipedes (Diplopoda)......	" Wireworms " (misnomer)	Destructive to vegetation, especially in cultivated areas.
Insects.		
Orthoptera—		
Forficulidae...............	Earwigs...............	Slightly destructive.
Phasmidae (especially Batrachoderma spp.)	Stick insects...........	Slightly destructive to foliage of indigenous seedling trees.
Acridiidae................	Short-horned grasshoppers	—
(Phymateus morbillosus)..	Non-migratory locust...	Destroys foliage of Virgilia capensis.
Locustidae................	Long-horned grasshoppers	Slightly destructive to various herbs.
Gryllidae.................	Crickets...............	Destructive to roots of various young trees.
(Gryllotalpa vulgaris).....	Mole cricket...........	—
Hymenoptera—		
Apis mellifica............	Honey bee............	Pollinates various spp.—*vide* "Agents of Pollination" Table 2, Appendix I.
Apis caffra..............	Wild honey bee........	Pollinates various spp.—*vide* "Agents of Pollination" Table 2, Appendix I.
Anthophora madecassa....	Humble bee............	Pollinates special flowers—*vide* Table 2, Appendix I.
Xylocopa spp. (olivacea, capensis)	Carpenter bees.........	Cut through bases of the flowers of certain spp., extract nectar, but do not pollinate flowers.
Vespidae and Eumenidae (Polistes and Eumenes)	Social and solitary wasps	Occasionally pollinate.
Tenthredinidae...........	Saw flies..............	Slightly damage foliage when this is young.
Cynipidae................	Gall flies..............	Slightly damage foliage, especially that of Rhus spp., Trichocladus crinitus.
Ichneumonidae...........	Ichneumon flies........	These are parasitic on a number of other insects, especially on some of the Lepidopterous larvae destructive to seeds of forest spp.
Coleoptera—		
Lamellicornia............	Chafers................	Larvae are root-feeders, adults attack foliage and young stems.
Chrysomelidae............	Leaf beetles...........	These are moderately destructive to leaves of various spp. of tree seedlings.
Cerambycidae............	Longicorns............	Attack stems of large trees, notably Celastrus acuminatus, C. peduncularis, Ocotea bullata. An unidentified larvae does much harm to sapling and seedling Ocotea, boring the pith and destroying the young wood.
Curculionidae (including the Scolytidae)	Weevils................	Very abundant—destroyers of boles of trees.
Lepidoptera...............	Butterflies and moths..	Numerous, but most of them of little ecological interest.
Papilio demodecus..........	Orange butterfly.......	Larvae destroy foliage, but adults pollinate various spp. notably Platylophus, Cunonia, Halleria, Burchellia.
Pyrameis cardui............	Painted Lady..........	Pollinates various flowers of the Macchia.

Table XXXI.—(Continued).

ZOOBIOTIC ASSOCIATES—(*continued.*)

Zoological Name.	Common Name.	Function and Remarks.
Various moths, notably :—		
Nudaurelia (Atherea) cytherea	Christmas worm........	Causes severe defoliation (larval stage) to Protea, Rhus, and exotic plants. (Pine, Eucalypts.)
Sphingidae—various......	—	Larvae bore in timber trees.
Noctuidae—various.......	Cut worms............	Larvae destroy regeneration of all species of trees, by nipping off the seedlings at the collars.
Tortricidae—various......	—	Larvae defoliate young trees and bind up the dry leaves into " nests."
Tineidae.................	—	Larvae cause some damage to foliage of tree seedlings.
Hemiptera—		
Antestia variegata........	Fruit bug..............	Punctures fruits of various forest species.
Holopterna vulga.........	Stink bug..............	Punctures new shoots of various species.
Aphidae....................	Plant lice..............	Frequent in flowers of Olinia cymosa, causing much damage ; occasionally on the foliage of Vergilia.
Coccidae....................	Scale insects...........	Locally abundant in beds of Olea laurifolia seedlings, causing poor growth and death. The disease does not spread rapidly.
Various unidentified mites...	—	Detrimental to the foliage of various species. One species forms pockets on the foliage of Ocotea bullata (Phillips, J.F., 1924) (1).
BIRDS.		
Amydrus morio............	Rooivlerk spreeuw......	Seed dispersal and insect destruction.
Spreo bicolor...............	Witgat spreeuw........	Seed dispersal and insect destruction.
Lamprocolius melanogaster..	Black-bellied starling...	Seed dispersal and insect destruction.
Oriolus larvatus............	Black-headed oriole.....	Seed dispersal; destruction of insects, especially of honey bees.
Hyphantornis velatus.......	Masked weaver.........	Seed dispersal along water-courses ; occasionally a pollinator.
Sitagra capensis............	Cape weaver...........	Seed dispersal along water-courses ; occasionally a pollinator.
Estrilda astrilda............	Waxbill................	Dispersal of small seeds, occasionally a pollinator.
Serinus canicollis...........	Cape canary...........	Dispersal of small seeds.
Promerops caffer...........	Cape sugar bird	Pollinator.
Cinnyris afer...............	Greater sugarbird.......	Pollinator.
Cinnyris chalybeus..........	Lesser sugarbird........	Pollinator.
Cinnyris amethystinus......	Black sugarbird........	Pollinator.
Zosterops capensis..........	Cape white eye.........	Pollinator ; destroys small insects (Coccidae), and disperses small seeds.
Parus afer..................	Blackbreasted tit.......	Destroys insects, especially Coccidae.
Aegithalus minutus.........	Kapokvogel............	Destroys small insects.
Camaroptera olivacea.......	—	Destroys small insects.
Turdus olivaceus...........	Cape thrush............	Destroys insects.
Cossypha caffra............	Cape robin.............	Destroys insects.
Cossypha bicolor...........	Noisy robin............	Destroys insects.
Dicrurus afer...............	—	Kills large numbers of honey bees.
Campophaga nigra..........	Black cuckoo shrike.....	Destroys insects.
Campophaga hartlaubi......	Yellow cuckoo shrike...	Destroys insects.
Upupa africana............	" Hoopoe "............	Destroys insects.
Irrisor viridis..............	Wood hoopoe..........	Destroys insects.
Caprimulgus pectoralis......	Cape nightjar..........	Destroys insects.
Colius striatus..............	Muisvogel..............	Seed dispersal.
Lophoceros melanoleucus....	Crowned hornbill.......	Seed dispersal ; destroys insects.
Campothera notata..........	Knysna woodpecker....	Destroys insects.
Dendropicus cardinalis......	Cardinal woodpecker....	Destroys insects.
Indicator major............	Yellow honey bird......	Destroys insects.
Indicator minor............	Lesser honey bird......	Destroys smaller insects.
Cuculus solitarius..........	" Piet-myn-vrouw ".....	Destroys insects.
Chrysococcyx smaragdineus..	Green cuckoo..........	Destroys insects.
C. cupreus................	Golden cuckoo.........	Destroys insects.
Centropus Burchelli.........	Vlei lourie.............	Destroys insects.
Turacus corythaix*.........	" Lourie ".............	Seed dispersal.
Columba phoenota..........	Bush dove.............	Seed dispersal.
Columba arquatrix†........	Bush dove.............	Seed dispersal.
Turtur capicola............	Turtle dove............	Seed dispersal.
Chalcopelia afra............	" Blaarduif "...........	Seed dispersal.
Haplopelia larvata..........	Cinnamon dove........	Seed dispersal.
Stephanibyx coronata.......	Crowned lapwing.......	Destroys insects, and disperses small seeds.

* *Vide* Phillips, 1927 ; (7). † *Vide* Phillips, 1928 ; (7).

Table XXXI.—(Continued).

ZOOBIOTIC ASSOCIATES—(*continued*).

Zoological Name.	Common Name.	Function and Remarks.
MAMMALS.		
Potamochoerus choeropotamus*	Wild or bush pig.......	Disperses seeds; destroys seeds.
Tragelaphus sylvaticus......	Bushbuck.............	Dispersal and destruction of seeds; destruction of several species of tree-seedlings.
Cephalophus monticola......	Bluebuck..............	Dispersal, and slight destruction of seeds.
Pediotragus tragulus........	Grijsbok..............	Dispersal of seeds; destruction of regeneration of certain species of tree-seedlings.
Lepus capensis.............	Cape hare.............	Destruction of marginal regeneration, coastal forests.
Dendromys melanotis.......	Grey treemouse........	Seed dispersal and destruction.
Bathyergus maritimus......	Sand mole.............	Destroys bulbs and roots.
Hystrix africae-australis.....	South African porcupine	Destroys bulbs and roots.
Procavia capensis..........	Rock rabbit...........	Destroys foliage, bulbs, roots.
Elephas africanus (subspecies)†	Knysna-type of African elephant	Seed dispersal and destruction of vegetation. (Phillips, 1925. (4).
Rousettus collaris..........	Common fruit bat......	Dispersal and destruction of seeds.
Cerceopithecus pygerythrus..	Vervet monkey.........	Dispersal and destruction of seed; destruction of bulbs, roots, and insects.
Choiropithecus porcarius....	Baboon................	Dispersal and destruction of seed; destruction of bulbs, roots, and insects.
Felis caffra.................	Wild cat..............	Occasionally disperses drupes of
Mellivora ratel.............	Ratel.................	Destruction of honey bees and of honey.

Man.—The influence of man has been discussed under Chapter III‡, and needs no further treatment here.*

* Potamochoerus: *vide* J. F. V. Phillips, 1926 (6).
† Elephant: *vide* J. F. V. Phillips, 1925 (4).
‡ Influence of Man: *vide* also Chapter (4).

* Phillips, 1930; (1) considers man as part of the *plant-and-animal, or biotic community*—as in exploited forest at Knysna.

Chapter III.

THE FORESTS: A BRIEF SUMMARY OF LITERATURE AND HISTORY.

Chapter III.

THE FORESTS: A BRIEF SUMMARY OF LITERATURE AND HISTORY.

Literature.

Although the forests of the Knysna have been known to Europeans since 1711, and although the region was visited as early as 1772 by Thunberg, and since then by a number of other eminent botanists, there is practically no literature of phytogeographic or ecologic nature.

The writer, in a special Departmental monograph entitled "The Midland Forests: a Brief Historical Account of their Management," has shown that the fragmentary records in the possession of the Forest Department are of purely historic or semi-sylvicultural interest only. Leaving, then, purely forestal reports out of consideration, we find that, until the appointment of Dr. L. Pappe as First Colonial Botanist in 1858, no reliable descriptions of the forests and macchia of the region were available. Apart from passing remarks by Lichtenstein (1812), the region received scant mention by any of the botanists who had visited it.

Pappe visited the forests and macchia about 1859–60, and in his annual report describes their nature. He records the unsatisfactory manner in which the forests were being conserved. Fire he declares to be taking heavy toll year by year. He drew upon the forests for herbarium and timber specimens, and shortly after prepared his very useful little work, "Silva Capensis" (1862: London), in which brief descriptions of the chief timber species were given, together with notes concerning their habits, habitats, and uses.

On the death of Pappe in 1862, the versatile Dr. H. Croumbie Brown, was appointed to the post. He visited the Knysna about 1862–3, and in his report describes the forests and, to a somewhat greater extent, the various abuses to which they were subjected. In 1887 appeared his "Management of Crown Forests at the Cape," in which he gives many notes of interest to the present-day ecologist paying attention to succession on burned or exploited forest-land.

In 1898 E. Knoblauch published an autecological contribution to our knowledge of certain forest trees and shrubs of the Knysna, entitled "Oekologische Anatomie der Holzpflanzen die Zud Afrikanischen Immergrünen Buschregion" (Tubingen: 1896). This work is difficult to obtain.

In the same year Marloth and A. F. W. Schimper visited the region, and in "Das Kapland" (1908: pp. 187–197, 207–210) record their impressions.

Marloth discusses the extent and climatic factors of the forests, and lists the chief species of trees. Adopting figures supplied by Conservator C. B. McNaughton, he sets forth the composition of the forests, in terms of percentage stocking of the various tree species; he arranges the species into five height-classes. Short lists of forest shrubs, herbs, ferns, and epiphytes are given, while the vegetation of the forest margins is dealt with concisely. Interesting points concerning the general ecology of the forest species receive notice. A useful account of the original extent of South African forests is furnished.

A. F. W. Schimper, under the title of "Der Knysna Wald,"* presents an excellent account of the nature and general ecology of the forests and macchia: we are fortunate in possessing even this all too brief description from the facile pen of the noted phytogeographer. Schimper briefly discusses the present extent of the forests, and leans to the opinion that they did not at one time entirely cover the face of the country, but that existing areas of macchia, on the advent of the white man, had been very considerably increased in extent by axe and flame. He outlines the nature of the habitat, the nature and composition of the forests, and notes points of difference between them and tropical ones. His remarks on this subject are so much to the point that they bear citation here, verbatim:—

> ". . . Mit dem tropischen teilt der temperierte Regenwald den hygrophilen charakter, das immergrüne Laub, die Holzlianen und, in floristischer Hinsicht, die bunte Mischung aus verschiedenen Arten. Er unterscheidet sich von demselben durch die reichere Verästelung der Bäume, die geringere Grösse der Blätter, wormit geringere Frondositat und derbere Laubbeschaffenheit zusammenhängen, Fehlen der Flügel en den Baumstammen, Seltenheit der Traufelspitze, geringere Mannigfaltigkeit der Lianen, geringere Menge und Mannigfaltigkeit phanerogamischer Epiphyten, Reichtum an epiphytischen Moosen und Flechten. In jeder Hinsicht ist durch das eben Gesagte der Knysna-wald ökologisch charakterisiert. . . ."

He touches upon the irregular height of the forest canopy, the mixed nature of the forests, describes certain of the trees and shrubs, and refers to various ecological points. Gerhard (1902) describes the leaf-structure of several Knysna Forest species.

T. R. Sim, in his valuable "Forests and Forest Flora of the Cape Colony" (Aberdeen, 1907), gives a short account of the forests, and indicates several species of trees peculiar to, or absent from, them. In the descriptions of the forest and scrub species of the Colony, many interesting points are given *re* habits, habitats, and communities.

J. S. Henkel (1912) in a brief paper describes certain features of the forests.

I. B. Pole-Evans (1920) dismisses the forests of the Knysna in a single paragraph, merely listing some of the species, and pointing out the presence of Virgilia, which does not occur in the eastern forests.

In a later paper (1922: 50), Evans considers the forests of the Knysna as mere outliers of the forests on the southeastern slopes of the Drakensberg.

J. F. V. Phillips (*vide* Bibliography for references) has contributed to the ecology of several of the more important species of forest trees and forest animals. In a Forest Department report, Phillips (1924: ii) has described the principal features of the history of forest management for the period 1778–1909.

Bews (1925), in his stimulating "Plant Forms," laden with suggestive material along the line of the use of the phylogenetic method in taxonomy, refers to the Knysna Forests. He notes the successional role of Virgilia, lists the more important species of trees and shrubs, and then states that the forests are but outliers of the eastern forests, within the southwestern region. The forests are considered to be "intimately connected with the southwestern vegetation," which they replace in the process of succession.

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* Das Kapland: 207-210.

Reference to the description of the region on vegetation maps by various botanists between 1843 and 1923 is not out of place here :—

Date.	Author.	Description.
1843........	Drege, J. F.................	IVC. included in his " Terra inferior *australis.*
1871........	Grisebach...................	*Kapflora*, in common with practically the whole of the country south of the Orange River.
1880........	Rehman......................	*Waldgebiet*, (from 22 deg.–26 deg. E. long. approx.)
1882........	Engler, A...................	*Sudliches Kapland.*
1886........	Bolus, H....................	*Southwestern region* . . . included in.
1887........	Drude.......................	*Immergrüne Waldregion*, as contrasted with the *Immergrüne Buschregion* (Macchia) of the Cape.
1898........	A. F. W. Schimper.........	*Regenwald*, as contrasted with the Macchia of the Cape. (Hart laubgeholze.)
1905........	Bolus.......................	*South-western region* (as in 1886).
1908........	Marloth.....................	*Waldprovinz* or *Sudl. Waldgebiet*, whereas he terms the Cape flora " Reich der Kapflora."
1920........	Pole Evans..................	*South-western veldt*, in common with the flora of the Cape Peninsula.
1923........	Shantz and Marbut.........	*Temperate Rain Forest.*

* Tansley (1913: 32) cites the Knysna Forests as an example of Brockmann-Jerosch's (1912) "*Laurisilvae.*"

J. F. Phillips prefers to term the region that of " *Temperate-form Subtropical Forest,*" for the reasons that *climatically* and *constitutionally* the Knysna Forests are more temperate than those of the eastern Cape, of Natal, and of the Transvaal, and that at the same time they are composed of species definitely derived from tropical ones. Ecologically, too, they show marked signs of having been derived from the tropical forests of east and central Africa.*

The region has been visited by various botanists interested in the collection and description of the plants. Of these, the better known are as follows :—

Date.	Botanist.	Remarks.
1772........	Thunberg, Carl.............	(1823). Collected and described a large number of plants.
1773........	Thunberg, Carl.............	(1823). Collected and described further plants.
1772........	Auge, J.....................	Collected with Thunberg.
1773........	Masson, F...................	Collected with Thunberg.
1775........	Sparrmann, A...............	Collected.
1798–1803...	Niven, J.....................	Collected.
1803........	Lichtenstein, H.............	Collected. Remarked on region (1812).
1814........	Burchell, W. J..............	Collected.
1817–1822...	Bowie, J.....................	Collected.
1829–1834...	Drege, J.....................	Collected.
1860 (*circa*)..	Pappe, L.....................	Collected. Remarked on Forests.
1862........	Brown, J. Croumbie.........	Described Forests and the abuses to which they were being subjected.
1870........	Bolus, H.....................	Collected and described.
1875–80.....	Rehmann, A..................	Collected. Remarked on region (1880–1881).
187?........	Schlecter, R.................	Collected.
1894........	Penther, A...................	Collected.
1897........	Galpin, E....................	Collected.
1898........	Marloth, R...................	Outlined nature of Forests and Macchia (1908).
1898........	Schimper, A. F. W..........	Contributed a short note on the Forests (*vide* Marloth 1908: 207–210).

More recently, much collecting and identifying have been done by H. G. Fourcade, S. Schönland, and others.

The more important literature relating to the systematics of the region is listed in the Bibliography.

* See Chapter VIII.

History of the forests.

(1) *Prior to the Advent of the European.*

Reliable information concerning the Knysna region ere its occupation by the white man is extremely meagre. The western forests of "Houteniqualand," or of the "Outeniquabergen," as they were then called, were actually discovered by the Dutch about 1711, but no descriptions of these at that date are available. Although these western forests were visited again in 1727 by the then Governor of the settlement at the Cape, it was not until 1778 that the region in which we are directly interested was entered by Dutch settlers. The latter took up their abode in the vicinity of Bahia Formosa, or, as it was in 1778 re-christened, Plettenberg's Bay. What the nature of the area was on the coming of these settlers will never be known fully, but several references from old records, and careful study of the plant succession itself, lead one to conclude that the Outeniqua, a semi-nomadic tribe of Bushman-Hottentots of small stature and primitive intelligence, were denizens of the forests and surrounds, and were to some degree responsible for forest destruction. Their hunting pits, utensils, and middens may be found in forest and macchia alike.

Diaz and Da Gama in the late fifteenth century, in their logs, refer to dense smoke banks that hung over the country as black palls, the flames themselves at times being visible to the mariners several miles out at sea. While much of the smoke may have arisen from firing of the macchia contiguous to the forests, there is little doubt that forest itself too often formed the fuel for the flames. Fires usually originate along the margins of South African forests, but in dry spells these can readily arise within the latter. The hunting pits relict of the days of the Outeniqua are to be found in the heart of the forests, testifying that the pygmies were indeed forest frequenters. It is significant that pits are found in larger or smaller macchia "eilands" (Dutch for "islands") occurring in the midst of forest; the origin of such "*eilands*" it is permissible to attribute to the destructive propensities of the extinct tribe of hunters responsible for the making of the pits. The depth of charred roots and stumps, the depth and nature of incinerated layers of soil, the depth of humus, and the nature of the plant communities in the vicinity of such pits, give clues to the ages of the "eilands."

Animals such as elephant and buffalo were hunted, and if wounded and at bay, were often "smoked out" by the easy means of firing the vegetation in which they had taken up their stand.

What it is desired to emphasize is that, while forest devastation received a fillip during the first century of the occupation by the European, *actual destruction did occur long ere he entered the land.*

The origin of fires from lightning, it might be argued, would not be uncommon throughout the ages. It is necessary, therefore, to record that it is extremely seldom that lightning-struck vegetation continues to burn after the initial singeing; moreover, reference to the chapter on Climate (Chapter II) will show that lightning extremely rarely occurs in the greater portion of the region.*

As the Outeniqua herded no stock and had little use for timber in his household economy, he did no harm in the directions of grazing stock in and exploiting forest.

The original extent of the forests is discussed under a special section in Chapter X (pp. 233–234).

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* Fires due to lightning hav been recorded from other parts of South Africa.

(2) *Since the Advent of the European.*

The settlers in the vicinity of Plettenberg Bay, about 1779–80 commenced to draw upon the forests for timber; they also cleared portions of ground of forest, bush, and macchia for the growing of crops and the pasturing of cattle. In addition to the settlement at the bay, a "Company's Woodcutters' Post" was established on the site of the present town of George, 1777–78. Le Valliant, the noted French naturalist who toured the region in 1781, camped at the post, and describes in his "Travels" (1783) how timber was exploited by the servants of the Company, and was transported overland to the distant Cape. Le Valliant is further informative in that he writes of the degenerate hewers of timber living in the vicinity of Plettenberg Bay, in the localities known as "De Poort" and "Wittedrift." These people cleared forest for the sake of the timber, which was sold to the Resident at the bay, and also for tilling and grazing purposes.

As the detailed records of forest management are given in J. F. Phillips's (1924 : ii) "The Midland Forests: a Brief Historical Account of their Management," there is no need for a protracted description of the gradual increase in forest devastation by axe and flame until the introduction of an adequate system of conservation was at last brought about, through gradual evolution of policy, between the years 1874 and 1883. It will be sufficient to summarize here the history of treatment of the forest between 1778 and 1883.

Period.	History of Treatment.
1778–1811...	Commencement of exploitation. Clearing of Forest for agricultural needs.
1812–1821...	Introduction of some measure of control by the British Admiralty. Felling, burning, and general destruction still continued, as no active steps were taken to prevent abuses.
1822–1855...	Forest devastation at its height; reckless fellings and burning the order of the day, despite the formation of a weak Forest staff in 1847.
1856–1873...	Forest abuses slightly decreased in degree, but much felling and burning still continued although the Forest staff was larger and more active than formerly.
1874–1882...	Further decrease in abuses, chiefly due to the improved staff. First attempt at systematic management made by Conservator, Captain Harison.
1883........	Abuses gradually decreased until they became practically non-existent by about 1890. Improved systems of conservation and management were gradually introduced.

Points of considerable ecological importance arise from a study of the forest management between 1778 and the present day. Briefly, the more important are the following:—

1. Until 1882, trees required for exploitation purposes were culled from any portion of the forests—perhaps many years elapsing ere the removal of a second tree adjacent to the site of one removed previously. Large exploitation areas were thus non-existent, and the natural regeneration arising on the sites of the single trees removed, not being exposed to severe insolation or competition with weeds, comparatively speedily healed the rupture in the canopy.

The method of exploitation thus nearly approached the natural manner in which old age, wind storms, disease, and other factors eliminate individual trees, thus presenting conditions favourable to the establishment and growth of regeneration. After 1882, definite portions of forest were exploited, often fairly severely. The concentration of fellings resulted in the excessive rupture of the canopy, deterioration or destruction of forest conditions, and general depreciation of the value of the forest sylviculturally and financially. Weeds colonized the opened-up areas, and either gave way to shrub and tree stages slowly, or else remained in possession as subclimax communities.

2. For many years the only species exploited were the two Podocarps and *Ocotea bullata;* small quantities of Apodytes, Olinia, and Curtisia were also drawn from the forests in certain localities. *Olea laurifolia*, the most abundant

species in the forests, was not exploited until late in the " nineties " of last century. The tendency was for the number of large individuals of the Podocarps and Ocotea to be decreased considerably, as compared with those of other tree species. Indeed, it was urged by Hutchins (1888–1890) that " ring-barking " of the Olea and other " inferior " species was essential to the maintenance of the proper stocking of the more valuable species.

3. For many years the finest trees only were felled, the unsound, diseased, malformed individuals being left in the forests ; the quality of the forests was thus much depreciated.

4. For a time the minimum girth limits of exploitation were too low, with the result that most of the large but as yet immature trees were removed, with consequent reduction of the general height of the forest canopy and extreme introduction of insolation to the seedling and sapling stages.

5. Systematic firing of macchia on the margins of the forests, as well as far removed from them, was initiated, the outcome being the destruction of the seral stages leading from macchia to forest, and the throwing back of the succession to zero.

6. The introduction of exotic trees—chiefly eucalypts, acacias, pines—into macchia, along the forest margins, and into opened-up areas in the forests themselves, was commenced in the " nineties." This has, in some respects, complicated successional changes, and may yet prove a factor of the very greatest economic as well as ecologic importance. Artificial climaxes of fast-growing, moisture-voracious, and strongly regenerating exotics, brought into being in the midst of a natural vegetation much disturbed and not particularly aggressive, may provide interesting material for study from various aspects in future years.

Chapter IV.

THE PLANT SUCCESSION: PRINCIPAL STAGES OF THE FOUR SERES.

(INITIAL and MEDIAL)

Chapter IV.

THE PLANT SUCCESSION: PRINCIPAL STAGES OF THE FOUR SERES (INITIAL AND MEDIAL).

The principal stages of the four seres—the *Hydrosere* (the stages originating in free water surfaces or very moist soil), the *Halosere* (the stages originating in saline water or on saline soil), the *Psammosere* (the stages originating on sandy surfaces), and the *Lithosere* (the stages originating on rocky surfaces)—are discussed briefly, in order of the plant succession; initial stages first, medial stages later. It will be seen that the four seres converge on macchia, from which scrub, bush, and forest develop in due course; accordingly stages of higher development than macchia are not dealt with in this chapter, with the exception of several anomalous communities in the *Hydrosere*. Scrub and bush are described in Chapter V, and in Chapters VI, VII, IX, and X forest is treated. In Chapter VIII the general tendencies of the plant succession within the Knysna region are summarized. The schematic chart (in separate cover) gives a graphic impression of the principal stages of the four seres and of their interrelations.

The seres are described in the following order:—

(1) The Hydrosere.
(2) The Halosere.
(3) The Psammosere—
  (*a*) On the coast.
  (*b*) Inland.
(4) The Lithosere—
  (*a*) Inland.
  (*b*) On the coast.

The data submitted, based where possible on *quadrat* studies, but for the greater part on *inference* and *sequence* studies and observations, are to be considered preliminary, and in instances incomplete. Further *quadrat* and *sequence* studies conducted over a decade or two, are likely to produce information concerning the several seres and the relationships of the various stages, at present not available—at the same time the present account prepares the way for a later and fuller monograph.

The Hydrosere.

Areas.—Free water surfaces—rivers, streams, vleis, flushes.

The pioneer communities commence life in free water. Through reaction of community upon the habitat—especially on the moisture content of the substratum—and the reciprocal reaction of habitat on community, successive stages proceeding toward the mesophytic are accompanied by equivalent advances of the moisture conditions toward the normal.

Apart from the lakes of George and Knysna, the region to-day does not present any great development of primary water surfaces, but at the same time numerous fragmentary examples are to be found. When we realise the very fair extent of soil now bearing the penultimate and ultimate stages of the hydrosere, it appears that in past ages there must have been a greater development of water surfaces or of very moist, swampy areas.

The various initial and medial stages to be described are not always found occurring in the regular, diagrammatic zonation that may be supposed from a glance at the schematic chart. These are indeed often interrupted, either through the abscence of one particular stage, the interpolation of another, or the earlier or later appearance of yet another.

Careful study of the several stages and of the habitat conditions controlling and in turn controlled by these, enables one to piece together the more important stages in the succession, even if these be separated in space.

The major stages only are described.

(1) *The Stage of Submerged and Partially Submerged Hydrophytes.*

The plants occurring in this stage are rooted in the mud and ooze at the bottom of the water surfaces. Where this stage is represented, the water is seldom more than from two to three feet deep, and usually about one foot to one and a half feet only. The water of the " vleis " and " flushes " is usually very poorly aerated, contains much organic matter, and shows pH values between pH 5·8 and 6·5; the marginal water of larger streams and rivers, however, is less acid, the values lying between pH 6·2 and pH 6·8. These values naturally vary with degree of rainfall—the water being more acid immediately after a heavy fall, or during times of stagnation as the result of drought. A point of some importance so far as light-intensity at the various depths is concerned, is that the water is usually from pale brown to very dark brown, although entirely transparent. This is found to be due to organic matter in solution. Examination of the submerged communities in dark-coloured water has shown that these are floristically poor, and in addition, are frequently of low absolute density of stocking.

The usual conditions in fresh water are as follows :—

Well represented are Potamogeton fluitans, P. americanus, and less often P. lucens ; these, in deeper water, are entirely covered, but in shallower " vleis " and along the margins of slow-flowing streams often have their leaves above the water-level, or resting thereon. They form dense consocies or associes, and considerably decrease the light-intensity for their own regeneration and for such Characeae as may be present. On occasion their foliage thins out, and doubtless it is at such times that the sunken achenes germinate and produce young plants. Ceratophyllum demersum is a common plant in certain water bodies, is rare or entirely absent in others. Where abundant—as in some of the George and Knysna lakes—it forms dense consocies, or may form a layer socies to the Potamogetons. Another interesting plant of this zone is Lagarosiphon muscoides, forming close consocies from eight to sixteen inches in height, or growing in associes with Crassula inanis ; it very often occurs in later stages as a semi-aquatic. Crassula inanis behaves in a similar manner.

In many localities a characteristic plant of the submerged zone is Myriophyllum spicatum, sometimes forming associes with the species above mentioned. but more often in pure layer socies. Utricularia exoleta favours muddy-bottomed bodies and river estuaries ; it may either float or be submerged.

As pointed out by Bews (1920 : 396) in describing this stage for the coast-belt of Natal, these plants are by no means wholly submerged, but may often be found with their foliage several inches out of the water.

The length of time for which the typical submerged communities hold sway, varies considerably. Some examples, in small vleis, have been noted to yield place to the semi-aquatic communities in several years, but no difference in the condition of water-covered communities growing in larger bodies of water, has been noticeable in the space of three years. The production of higher stages is, of course, much delayed by damage done to the successional stages by severe droughts or floods.

The chief reaction of this stage is the formation of a raw litter or humus that in the course of time raises the level of the soil and adds body thereto, as well as adds slightly to its chemical constituents. Gradual improvement of the factors renders establishment of invading germules of the next stage possible. All gradations of invasion by this more advanced stage are found in any one water surface.

(2) *The Stage of Floating Aquatics.*

The first representative of this stage, wherever the organs of attachment of the constituent plants are rooted in mud, ooze, and humus formed by the reaction of stage (1), is Aponogeton distachyon, which in time forms colonies, and later, consocies; the latter may cover many square yards. Nymphaea stellata is another important plant, but is more frequent near the coast. It builds small consocies, but may also occur in associes with Aponogeton and other species. In late summer its great blue flowers produce a fine effect. The extensive floating leaves of Nymphaea are responsible for the disappearance of portions of the stage of submerged hydrophytes—as the result of light interception.

Small colonies of Lemna gibba and Wolffia arrhiza are to be found along gently flowing streams; Limnanthemum Thunbergianum is very common, its small but abundant floating leaves covering the water for many yards.

Utricularia exoleta may occur in this stage.

The reactions of the floating hydrophytes are also in the direction of added humus and more stable soil conditions, but the rate of change is slow.

There are four possible successors to the above stage, and these will be described in turn, the most common first.

(3*a*) *The Typha capensis Consocies.*

Typha capensis, in river estuaries where the water varies from weakly saline to fresh, and in inland lakes and "vleis," as well as along river banks, forms luxuriant consocies. The water may vary from several feet to several inches in depth; often the height of the Typha above the water is from three to five feet. The stage follows on that of the floating aquatics comparatively quickly; appreciable advance of the rushes is made in several years. Nymphaea and Limnanthemum for a time persist among the latter, but as the density of the rushes increased, the floating aquatics are ousted. Sometimes the floating aquatics may be omitted, the Typha following directly on the submerged aquatic stage.

The rushes gradually react upon the water surface to such an extent that in the densest parts of the community the investigator may walk without getting his feet more than damp. The dense mass of root and foliage presented by the community efficiently collects matter in suspension in the water, and this, together with the fall of Typha leaves and other debris, goes a long way toward converting the site from a free-water one to a silty, muddy one.

3 (*b*). *Phragmites communis Consocies.*

The cosmopolitan grass, Phragmites communis, often follows on the floating aquatic stage, but may like Typha capensis, follow directly after the initial stage of submerged plants. Phragmites forms consocies from six to eight feet in height above the water-level, as much as from two to three feet of the stems being below the surface. Although the reeds rapidly produce a dense community, they do not so readily build up a more stable substratum at their bases. Debris and matter in suspension are combed out, but to a lesser extent than in the Typha community. Very occasionally the exotic Arundo donax is found mixed with the Phragmites—Bews (1920: 397) records the same position in Natal.

3 (*c*). *Phragmites-Typha Associes.*

Phragmites and Typha are to be found in well-constituted associes of considerable extent. The origin of these communities is traceable to two distinct courses of events. In one instance, Typha and Phragmites happen to advance upon, and to colonize the same zone at the same time; they are species that do not react upon each other, and hence form within a short time a strong associes. In the other instance, Typha forms an open community which is invaded by Phragmites before the Typha consocies has become too dense.

Considerable biotic interest centres in the formation of the reed and rush communities. Before their advent the water body supports little life, but when these species have built up a luxuriant zone, it is noticeable that bird life increases. The finches (weaver-birds) find their home in the reeds, and rear their young therein; the moor-hen seeks seclusion and forms colonies in among the rushes, while various species of duck, diver, teal, and snipe make their headquarters therein. Among mammals the Cape otter finds his lair in this vegetation.

3 (*d*). *Phragmites–Typha–Cyperaceae Stage.*

Phragmites communis, Typha capensis, and various Cyperaceae may be associated. Chief among the Cyperaceae found in such associes are the tall (eight-feet high) attenuated Scirpus littoralis, and the smaller, profusely developed Fuirena hirta, F. Ecklonii, and Eleocharis limosa. Cyperus sp. nov. (Schönland) standing several feet above the water, with much the same habit as Scirpus littoralis, also occurs in this stage. The Cyperaceae appear only in such places where the reeds and rushes are not over dense.

4. *The Stage of Semi-Aquatics.*

The stage of semi-aquatics may follow directly on that of the submerged aquatics, or on that of the floating aquatics, where the depth of water is insignificant throughout the year, or where seasonal fall of the water level results in the production of areas of sandy or silty alluvium, that bears little or no free water. The usual procedure, however, is for the stage to develop via one or other of the Phragmites and Typha communities already described.

The term "*semi-aquatic*" appears a vague one, but in reality it is preferable to any other that has occurred to the writer. It is employed in the same sense as that used by Bews (1920: 397), and is meant to include all light-demanding species which occur near to the margin of free-water surfaces; it is evident therefore that many species included in the category "*marsh-plants*" are embraced by the term. Certain light-demanding macchia and forest plants of locally wet or very damp soils, too, fall within the class. The typical plants of this stage are capable of undergoing without harm, periodic inundation; they are also able to suffer long-continued abundance of moisture around their roots; they thrive better in soils of high holard than in those of medium or low.

The semi-aquatic zone is diagrammatically exterior to the Phragmites zone and immediately interior to the zone of large Cyperaceae later to be described. In Nature, however, its position in the zonation is liable to modifications: thus, it may be exterior to the Cyperaceous zone, or may border immediately on that of the floating aquatics. Successionally, however, it certainly does replace either the Phragmites–Typha zone or that of submerged aquatics. The reaction is in the direction of continued stabilization of the soil, and of its enrichment by the addition of organic and inorganic foods. Physically, the reaction is further reduction of ground water.

The plants of this zone are very numerous as to species, while the numbers of individuals, too, are large in the vicinity of extensive water bodies. The principal plants only will be listed:—

Smaller Cyperaceae are abundant as to numbers of individuals, the chief species being Scirpus prolifer, S. rivularis, Fuirena hirta, F. Ecklonii, Pycreus polystachyus, P. umbrosus, Carex aethiopica, Cyperus tenellus, Juncellus laevigatus, Eleocharis limosa; others are Bulbostylis humilis, B. collina, Carpha capitellata, Costularia brevicaulis, Chrysithrix capensis, Ficinia acuminata, F. capillifolia, F. albicans, F. fascicularis, F. bracteata, F. bulbosa, F. gracilis, F. ixioides, F. dasystachys, F. tenuifolia, F. scariosa, F. secunda, F. ramossima, F. stolonifera, F. quinquangularis, F. striata, F. leiocarpa, F. sylvatica, F.

trichodes, Tetraria capillacea, T. pleiosticha, T. sylvatica, Scirpus capillifolius, S. membranaceus, S. Ludwigii, S. Hystrix. Scirpus prolifer forms large and close consocies, or is in association with Juncus lomatophyllus, J. capensis, or J. oxycarpus; Ficinia capillifolia rapidly dominates large areas, and the same is true of Tetraria sylvatica. Pycreus polystachyus and Carex aethiopica occur in mixture with Mariscus congestus; Cyperus tenellus often claims quite large areas. Associated with the Cyperaceae and Juncaceae are various other Monocotyledons and a fair number of Dicotyledons. Present on sites of this class are thegrasses Achneria ampla, Danthonia cincta, Imperata arundinacea, Leersia hexandra, Diplachne fusca, Stenotaphrum glabrum, Sporobolus pungens, S. indicus, Pennisetum Thunbergii, Polypogon monspeliensis, P. tenuis, Panicum maximum, P. proliferum; these are always scattered and rather widely adaptable. They may occur in drier marshes and in moist macchia at later stages in the succession. Other plants represented are: Orchidaceae; species belonging to the genera Acrolophia, Corycium, Eulophia, Disa, Bonatea, Disparis, Holothrix, Pterogodium, Penthea, Monademia, Satyrium, Schizodium, Liparis, and Habenaria. Other Monocotyledons are Zantedeschia aethiopica (forms consocies many yards in area), Romulea chloroleuca, R. rosea, Tritonia spp., Watsonia spp., Moraea spp., Caesia Thunbergii, Kniphofia alooides, K. tricolor, K. unicolor, Ianthe spp., Restiaceae are not well developed, but species of the genera Thamnochortus, Elegia, Restio, Dovea, Cannamois, and Leptocarpus are present in small numbers.

Among Dicotyledons the more important parts are played by Ranunculus pinnatus, R. plebius, Hydrocotyle asiatica, H. verticillata, Chironia maritima, Villarsia ovata, Laurembergia repens, Gunnera perpensa, Drosera cuneifolia, D. capensis, C. cistiflora, Alechemilla capensis, Polygonum atraphaxoides, P. acuminatum, P. aviculare, P. senegalense (exotic ?), P. serrulatum, Rumex acetosella (exotic), Samolus Valerandii, Sutera spp., Limosella aquatica, S. grandiflora, the parasitic Melasma capense, and M. sessiliflora, Zaluzianskya africana, Z. capensis, Z. maritima, Ilysanthes riparia; the exotics ,Veronica Anagallis, V. chamaedrys, V. serphyllifolia occur occasionally near human habitations. Cliffortia odorata and C. ferruginea often form large consocies. In shady places Impatiens capensis is a common plant, forming rich consocies. Anchusa riparia is occasionally present, as are Myosotis afra-palustris, and M. intermedia; the exotic M. sylvatica grows near human habitations. Campanulaceae are represented by Wahlenbergia procumbens, W. stellaroides, W. undulata, Lobelia patula, L. tomentosa, L. pubescens, L. repens, L. villosa, L. hirsuta, L. coronopifolia, L. anceps, L. linearis. Sometimes Silene bellidioides, S. capense, and the exotics Spergula arvensis, Spergularia media, S. rubra, and Stellaria media are present. Compositae favouring the moist zones are Bidens pilosa, Cotula coronopifolia, Cryptostemma calendulaceum, Dichrocephala latifolia, Gerbera cordata, Hippia frutescens, Matricaria spp., Senecio spp., Sonchus oleraceus (exotic), Ursinia spp.,

Among the Crucifers are Cardamine africana and Heliophila spp. Geraniaceae show Geranium ornithopodum, G. incanum, G. canescens, and Pelargonium spp. Guttiferae are sparse—Hypericum aethiopicum, H. Lalandi. Labiatae are not very abundant—Leonotis leonurus, Mentha aquatica, M. longifolia, M. viridis, Plectranthus spp., Stachys aethiopica, Teucrium africanum, T. capense. Leguminosae are scanty—Indigofera spp., Lessertia spp., and Loddigesia oxalidifolia, and several Psoraleas being the only representatives of any importance. The exotic Trifolium repens is common in places. Lythrum hyssopifolium is the only member of the Lythraceae*. Finally, Oxalis spp., Galopina circaeoides, Valeriana capensis, Verbena bonariensis (exotic) are common.

* Exotic.

5. *The Stage of Tall Cyperaceae.*

Reference to the schematic chart (2) of the hydroseral succession will show the relationship of the stage of tall Cyperaceae to those stages that have already received description. Features of importance are that the Cyperaceous stage may follow directly after the floating aquatics, or may proceed via the semi-aquatic stage, and that the succession may follow on from the Phragmites–Typha stage direct, or may proceed from that stage to the semi-aquatic stage, and then to the stage under discussion. The various modifications that exist in the succession have made the study of the process less easy than was at first expected.

The stage of tall Cyperaceae is a well-defined one, very well represented along most of the larger rivers and " vleis." Judging from Bews's (1920 : 398) description of the hydroseral succession on the coast-belt of Natal, his Cyperus-Mariscus stage is the equivalent of the stage of tall Cyperaceae at the Knysna.

The stage is made up of tall-growing (six–eight feet high) Sedges of the species listed below :—

Mariscus riparius, Mariscus congestus, Cyperus immensus, Cyperus textilis, Cladium jamaciense, Carpha glomerata, Scirpus littoralis, and usually some of the smaller Cyperaceae : Eleocharis limosa, Fuirena spp., Pycreus polystachyus, Carex aethiopica and others.

The general reactions of the community are to add more body to the soil and to reduce the light-intensity on the floor to such a point that the less-assertive species of the invaded semi-aquatic stage are ousted. At the same time, a few of the species of the latter stage, notably certain of the smaller Cyperaceae, certain Orchids and Cliffortia spp. do manage to survive in association with the tall Sedges.

Juncus lomatophyllus and J. oxycarpus manage to grow along the outer limits of the Sedges. Near the ocean, Juncus maritimus and J. acutus may form extensive communities immediately exterior to the tall Cyperaceae.

Two courses are now open : The Sedge stage may give way to that of Hygrophilous Macchia direct, or, as is often the case, may yield place to that of the " Palmiet," Prionium palmita.

6. *The Prionium palmita or " Palmiet " Stage.*

The peculiar, woody-stemmed Juncaceous plant Prionium palmita is wide-spread in the region. The formation of communities of this species is a relatively slow process, the growth per annum of the Prionium being little, hence the development of Hygrophilous Macchia directly from either the Phragmites-Typha or the semi-aquatic communities must expedite the building up of this type of vegetation very considerably.

The endemic monotype produces stems varying in length from three to six feet, with diameters of from one to two inches ; the leaves form a dense apical rosette, the diameter of which may be as much as three feet. Prionium is abundant along river banks ; when burned the stems rapidly produce fresh shoots.

7. *Hygrophilous Macchia.*

The Hygrophilous Macchia is a most important stage in the development of the hydrosere ; so far as has been ascertained, all the later seral stages have their true origin in this community, and cannot develop direct from the lower Prionium, Cyperaceous, Semi-aquatic, Phragmites-Typha stages. Reference to the schematic chart (2) reveals that the Hygrophilous Macchia itself may arise in several distinct manners. Firstly, it may develop direct from the Phragmites-Typha stages, when the water-level is insignificant, or when locally drier areas exist within these stages. A second course is for it to follow on Prionium palmita. Lastly, the stage of semi-aquatics may directly yield place to it.

Hygrophilous Macchia is well developed along river beds, and moist valleys, on the lower, cool southern slopes of such valleys, and in the vicinity of large "vleis," and on local flushes. It also occurs along seepage lines on drier areas. According to locality the community shows much floristic as well as sociological variation; the number of dominants on any one area may vary from several to over a score; the height, too, may vary from several to ten feet. The density of the stands is naturally a feature of the particular dominants and subdominants present, but generally this may be described as being very close.

The stage is instrumental in bringing about many important changes in the soil, and at the same time introduces fresh biotic associates. In its taller portions it greatly influences the atmospheric factors.

So far as prime soil reactions are concerned, we find that reduction of holard, increase of chresard, decrease of soil acidity, improved physical conditions—depth, porosity—are brought about. Biotic changes involved are the increase in numbers of soil micro-organisms, the advent of earthworms in small numbers, the coming in of rodents (mice, voles, and hares), of small buck (Grijsbok, Bluebuck). Birds are abundant, including the doves and Cape partridges. Insect life as well as reptilian (lizards, snakes, rarely tortoise) shows a remarkable increase. Climatic changes are in the direction of slightly increased humidity of the air, greatly decreased air temperature, greatly decreased rate of evaporation, and reduced light-intensities—the relative humidity several feet above the ground, during the warm hours of the day may be increased from 60 to 80 per cent., the air temperature at the same level may be reduced from 85 to 65° F., the evaporation rate may fall from 30 c.c. per twenty-four hours to 15 c.c., while the light-intensity may show reduction from 1 to 1/50–1/100. A steady amelioration of the factor-complex is thus in operation; acting, as it does, over very lenghty periods of time, the Hygrophilous Macchia is in reality responsible for the conversion of extreme edaphic and climatic factors to ones less extreme.

The principal species and communities forming the stage are listed below. It is necessary, however, to point out that certain of the species are adaptable to somewhat drier conditions.

Neglecting sociological details, the species present are:—Thamnochortus argenteus, T. erectus, T. fruticosus, Elegia parviflora, E. equisetacea, E. asperiflora, E. spathacea, E. thyrsiflora, E. thyrsoidea, E. verticillaris, Hypodiscus albo-aristatus, H. striatus, H. ramosus, H. spp., Leptocarpus paniculatus, Willdenovia teres, Restio comosus, Restio MacOwani, R. giganteus, R. triticeus, R. compressus, R. spp., among the Restiaceae. Grasses are scattered, and are mostly of the same species as listed under "semi-aquatics," belonging to the genera Achneria, Danthonia, Imperata, Leersia, Diplachne, Stenotaphrum, Pennisetum, Polypogon, and Panicum. Cyperaceae are to some extent represented—principally by Tetraria spp. (T. capillacea, T. involucrata, T. robusta, T. secans), Ficinia spp. (e.g., F. capillifolia, F. leiocarpa, F. sylvatica), but with the exception of Ficinia capillifolia and Tetraria sylvatica, which form dense layer socies in certain places, these are of little sociological importance. Mariscus congestus and Carex aethiopica are common, but scattered. The orchids are abundant as to species, but also play a subordinate role sociologically; present are Liparis capensis, Holothrix villosa, H. pilosa, H. spp., Habenaria Dregeana, H. MacOwaniana, Eulophia aculeata, E. rupestris, E. tabularis, Disperis capensis, D. paludosa, D. disaeformis, Disa polygonoides, D. tripetaloides, D. glandulosa, D. cylindrica, D. cornuta, D. racemosa, D. spp., Pterogodium Newdigatae, P. acutifolium, Satyrium acuminatum, S. bicorne, S. outeniquense, S. Pentherianum, S. foliosum, S. erectum, S. candidum, S. ligulatum, S. spp., Monadenia micrantha, M. auriculata, Acrolophia micrantha, A. tristis, A. cochlearis, Bartholina Ethelae, Bonatea speciosa, Corycium nigrescens, C. carnosum, and species of Ceratandra, Browneea, Herschelia, Forficaria, Penthea, Platanthera, and Ceratandropsis. Iridaceae show Gladiolus Bolusii var. Burchellii, G. spathaceus, G. pulchellus, G. maculatus, G. spp., Romulea spp., Homeria collina, Moraea ramosa, M. tricuspis, Tritonia lineata, T. spp., Watsonia spp., Ixia polystachya, I. spp., Geissorhiza spp. Among the Liliaceae are Caesia Thunbergii, Bulbine spp., Bulbinella spp., Eriospermum spp., Tulbaghia spp., Kniphofia spp., Ornithogalum spp. Other Monocotyledons of importance are Juncus lomatophyllus, J. capensis, J. oxycarpus, Cyanotis nodiflora, and Zantedeschia aethiopica.

Dicotyledons are very numerous floristically and individually ; important plants are :—Berzelia lanuginosa, B. intermedia, B. commutata, B. abrotanoides, Brunia nodiflora, B. cordata, Pseudobaeckea racemosa, Nebelia palacea of the Bruniaceae ; Cluytia pulchella, C. affinis, C. alaternoides, C. spp., Adenocline spp. of the Euphorbiaceae ; the Gentianaceae provide Chironia melampyrifolia, C. linoides, C. peduncularis, C. spp., Sebaea spp., ; Geraniaceae are frequent—several species of Geranium and over a dozen species of Pelargonium ; Gunnera perpensa and Laurembergia repens of the Halorrhagaceae are abundant in open places ; Labiatae have Plectranthus spp. ; Stachys spp. ; Salvia spp. ; Teucrium spp. ; the parasitic Lauraceous Cassytha ciliolata may form untidy masses on the branches of various shrubs ; Leguminosae are abundant in species and in individuals—Aspalathus spp ; Crotalaria capensis, C. obscura, C. purpurea, Argyrolobium spp. ; Indigofera flabellata, I. procumbens, I. hispida, I. heterophylla, I. candicans, I. Zeyheri, I. ovata, I. coriacea, I. spp. ; Loddigesia oxalidifolia ; Podalyria calyptrata, P. cuneifolia, P. sericea, P. myrtifolia ; Psoralea pinnata, P. axillaris, P. bracteata, P. carnea, P. decumbens, P. repens, P. tomentosa, P. restioides, P. spp. ; Priestleya augustifolia, P. myrtifolia ; species of Rhynchosia, Vigna, Tephrosia, Lotononis ; Sutherlandia frutescens ; Malvaceae are not abundant—species of Malvastrum and Pavonia, and Sida triloba ; Myrica conifera represents the Myricaceae, and Myrsine africana the Myrsinaceae. Polygalaceae have Polygala oppositifolia, P. myrtifolia, P. pinifolia, P. virgata, P. hispida, P. bracteolata, and sometimes species of Muraltia ; Proteaceae apart from Leucadendron adscendens, Mimetes palustris, M. hirta, M. pauciflora do not occur abundantly at this stage ; Rosaceae contain some important plants—Cliffortia ferruginea, C. odorata, C. linearifolia, C. juniperina, C. sarmentosa, C. strobilifera, C. graminea, the exotic Rubus fruticosus is widespread, and in places R. rigidus and R. pinnatus are frequent ; Alchemilla capensis occurs in opener places. There are few Rubiaceae—Galium asperum, G. glabrum, Galopina circaeoides, Anthospermum spp. ; Rutaceae are very abundant—Agathosma ciliata, A. erecta, A. hirta, A. blaeroides, A. apiculata, A. serpyllacea, A. platypetala, A. pubescens, A. microphyllus, A. spp., Barosma lanceolata, B. ovata, B. scoparia, B. venusta ; Diosma vulgaris, D. ramossima ; Empleurum serrulatum—some of these are of importance sociologically. Grubbia rosmarinifolia is a common Santalaceous plant, while the semi-parasitic Thesium spp. (about twenty-five), too, are present ; of Scrophulariaceae there are Sutera affinis, S. microphylla, S. pinnatifida, S. stenophylla, S. cordata, S. brachiata, S. foetida, S. spp. ; the semi-parasitic Harveya capensis, H. hyobanchoides, H. tribulosa, H. purpurea, H. speciosa, and Hyobanche sanguinea ; Limosella aquatica occurs in damp places ; common are Melasma sessiliflorum, M. scabrum, M. luridum, M. capense ; Nemesia divergens, N. foetens, N. spp. ; Zaluzianskya spp. ; Diclis reptans also occur. Selaginaceae show several spp. of Selago and Hebenstreitia. Hermannia hyssopifolia, H. linifolia, H. spp. are the only plants in the Sterculiaceae. Thymeleaceae have Gnidia oppositifolia, G. denudata, G. nodiflora, G. orbiculata, G. scabrida, G. spp. ; Struthiola argentea, G. hirsuta, G. striata, G. spp. ; Lasiosiphon spp. Umbellifers present are Bubon capense, B. tenuifolium, B. hypoleucum, Foeniculum officinale, Hydrocotyle debilis, H. eriantha, Lichtensteinia spp.; Peucedanum capense, P. capillaceum, P. ferulaceum, sium Thunbergii, Hermas ciliata, and the variable Heteromorpha arborescens. Valeriana capensis is the only member of the Valerianaceae. The exotic Verbena bonariensis is locally abundant in many places. The Convolulaceae are represented by the parasitic Cuscuta africana, C. cassytoides, and C. appendiculata. Among Asclepiads are the poisonous Cynanchum africanum, C. capense, and C. obtusifolium; Asclepias fruticosa is locally abundant. The Campanulaceae present are chiefly species of Lobelia—L. anceps, L. repens, L. spartioides, L. pubescens, L. linearis, L. hirsuta, L. villosa, L. tomentosa, and L. coronopifolia; Wahlenbergia procumbens, W. undulata, W. stellaroides also occur. The principal Compositae are—Helichrysum felinum, H. foetidum, U. umbraculigerum, H. ericaefolium, H. petiolatum, H. odoratissimum, H. serpillifolium, H. capitellatum, H. appendiculatum, H. parviflorum, H. spp.; Senecio rigidus, S. lineatus, S. glastifolius, L. lyratus, L. crenatus, S. rosmarinifolius, S. spp.; Stoebe cinerea, S. alopecuroides, Ursinia anthemoides, U. subhirsuta; Hippia frutescens, H. pilosa, Pulicaria capensis, Peyrousea calycina, Pteronia spp.; Matricaria spp.; Leontonyx squarrosus, Osmites bellidiastrum, Helipterum eximium, H. canescens, Metalasia muricata, Athrixia capensis, Euryops abrotanifolius, Osteospermum coriaceum, Bidens pilosa. Species of Heliophila are the sole Crucifers. Drosera capensis, D. cuneifolia, and D. cistiflora are all the Droseraceae. The Ericaceae are very numerous as to species and also play an important part sociologically—Erica canaliculata, E. curviflora, E. cerinthoides, E. densifolia, E. copiosa, E. incoustans, E. formosa, E. gibbosa, E. seriphiifolia, E. discolor, E. viridiflora, E. scabriuscula, E. pectinifolia, E. astroites, E. tetragona, E. caffra, E. deliciosa, E. tenella, E. gracilis, E. glomiflora, E. quadrangularis, E. hispidula, E. arachnoides, E. leucopeltata, E. lanata, E. adunca, E. Nabea, E. floribunda, E. cubica, E. melanthera. Blaeria fuscescens, Simocheilus multiflorus, Salaxis puberula.

Among ferns are Pteris aqualina (Pteridium aquilinum), Blechnum punctulatum, B. tabulare, Pellaea quadripinnata, P. viridis, Gleichenia polypodioides, Todea barbara, Polystichum pungens. The Lycopods Lycopodium carolinianum, L. cernuum are occasionally found. Mosses and hepatics are not common.

These and other species are associated in various ways, the study of the various socies, consocies, and associes being a work in itself. No attempt will be made to list the very numerous communities that do occur, only the general stages of greater importance will be dealt with briefly:—

(1) Restiaceae are often pioneers of the stage—Thamnochortus, Dovea, and Restio particularly.

(2) Simultaneous with these, or shortly after them, appear the hygrophilous Cilffortia spp.—C. ferruginia, C. odorata, C. linearifolia, C. sarmentosa, C. strobilifera, C. graminea, C. juniperina—these build up associes with the Restiaceae, or else gradually oust the latter.

(3) The Bruniaceae, more especially Berzelia spp.; Brunia nodiflora follow, and associate with the Cliffortias, or may form such communities as the Berzelia intermedia consocies, the Brunia nodiflora consocies, and the Berzelia spp. associes.

(4) Following the Bruniaceae are such plants as Erica canaliculata, E. curviflora, E. densifolia, E. gibbosa, E. incoustans, which mingle with the Berzelia, Brunia, and Cliffortia, and in time form associes with them. Other species that may come in at this stage are the large Barosma scoparia, the tall "Berg Buchu," Empleurum serrulatum, Grubbia rosmarinifolia; Psoralea pinnata, P. spp.; Podalyria calyptrata, Crotalaria spp.; Cyclopia brachypoda, C. subternata, Cluytia affinis, C. alaternoides, Polygala myrtifolia, and many others.

These species continue to form associes one with the other, or to form pure consocies—thus a community rich in species and showing considerable variation sociologically, is built up.

(5) Proteaceae enter after the foregoing, forming luxuriant communities attaining eight to fifteen feet in height. The principal spp. are :—Protea cynaroides, P. lacticolor, P. neriifolia, P. Mundtii, P. longiflora ; Leucadendron plumosum, L. salignum, L. uliginosum ; Leucospermum conocarpum, L. glabrum ; Mimetes hirta, M. pauciflora, and Aulax pinifolia.

(6) Many species of the semi-aquatic stage persist as subdominants, in small ground socies, chief among these being the grasses, the Cyperaceae, the Orchidaceae, the Iridaceae, and the Liliaceae, various small Scrophulariaceae, Campanulaceae, Compositae, Droseraceae, Geraniaceae, Gentianaceae, Oxalidaceae, Rubiaceae, and Umbelliferae.

From the Hygrophilous Macchia development may proceed along several different lines. The macchia may remain climax, or may develop to scrub, this latter community being succeeded in due course by bush, and the sere terminated by forest of moist type. On the other hand, the Virgilia capensis consocies may follow the macchia and ultimately usher in bush, the latter developing into forest with time. Finally, macchia may yield place to the hygrophilous small tree stage, forerunner of either bush or the Platylophus communities.

Stages developed from Hygrophilous Macchia, but not in the direct sequence, are the Salix–Empleurum associes and the Strelitzia augusta consocies, the relationships of which are shown in the schematic chart.

These last-named stages are described below :—

8. *Salix capensis–Empleurum serrulatum Associes.*

Along several rivers Salix capensis Thunb. var. mucronata And., forms small associes with Empleurum serrulatum. The associes usually attain heights varying from ten to twenty feet, and is fairly open, the Salix throwing light shade and the Empleurum not possessing a heavy canopy.

The Salix is deciduous in winter. Associated with the dominants are various subdominants :—the shrubby Freylinia undulata, Cliffortia strobilifera, C. juniperina, Psoralea pinnata, Podalyria calyptrata, Cluytia pulchella, Phylica racemosa, Rhamnus prinoides, Polygala myrtifolia. Such minor plants as Scirpus prolifer, Juncus lomatophyllus, Zantedeschia aethiopica, Hydrocotyle asiatica, Laurembergia repens, and Galopina circaeoides may occur on the ground. The associes seems to remain in existence for considerable periods but ultimately develops into the river valley forest scrub later described.

9. *Strelitzia augusta Consocies.*

The giant Strelitzia augusta or " Wild Banana " forms consocies varying in height from ten to twenty feet. The simple stems of the Strelitzia are usually from six to twelve inches in girth at their bases, and bear giant leaves (from three to eight feet in length by one and a half to two and a half feet in width) towards their apices. The stocking is usually fairly dense, the foliage allowing little light to reach the ground. Considerable litter is added to the soil by the casting of the leaves and the frequent fall of stems. The rhizomes are not deeply placed, and the plants despite the splitting of their leaves parallel with the veins, are readily thrown by wind.

The plants produce flowers with white sepals and petals, and fruits with bright-coloured, hairy arils. The flowers are pollinated by the honey bee and by sunbirds (Nectariniidae). The seeds are borne by birds, but apparently are not eaten by them, the coloured arils acting as misleading attractions.

Associated with the opener consocies are sometimes subordinate spp., such as Zantedeschia aethiopica, Eulophia spp.; Acrolophia spp.; Disa spp.; Bonatea speciosa, Kniphofia spp.; Romulea, spp.; small Cyperaceae, and some herbaceous Dicotyledons.

According to Bews (1920: 415), Strelitzia in Natal follows "Umdoni," Eugenia cordata; at the Knysna the species comes in after establishment of the Hygrophilous Macchia. On the death of many of the plants—due either to old age or to wind—the consocies allows of the entry of such species as Sparmannia africana, Polygala myrtifolia, Osteospermum moniliferum, Rhamnus prinoides, Protea spp., Leucadendron eucalyptifolium, L. salignum, and Burchellia capensis, the true fore-runners of the medial forest stages. Shading of the Strelitzia slowly brings about loss of vigour, and the ultimate subjugation or destruction of the species in the community. Strelitzia is only occasionally found west of the Keurbooms River*.

The Halosere.

Areas.—Salt or brackish silt and sand flats and banks at the estuaries of rivers, these flats being in portions inundated twice daily, in others, at Spring or other exceptionally high tides only.

Silt and sand flats are extensively developed in the estuaries of the Knysna and Keurbooms rivers,† and bear a characteristic vegetation the principal features of which are described below.

The plant covering is poor in species, and in many portions, open in nature, being thus in keeping with the statement of Warming (1909: 218), that two features common to halophytic communities are *the exceeding poverty of the flora and the very open nature of the vegetation.*

In the Knysna and Keurbooms estuaries the gypsum derived from the Enon beds in the vicinity is acted upon by the common salt in the sea water, and produces sodium sulphate, which is innocuous to plants. Accordingly when higher portions of the silt and sand flats are suitably treated and irrigated, they serve for the growing of field crops of very fair quality. Those flats that are frequently inundated, of course, are useless for this purpose. In such places where gypsum does not occur but where Aeolian drift does, the sodium chloride is neutralized by the calcium carbonate in the sand. Portions possessing no gypsum and receiving no sand, remain strongly saline, and if frequently inundated, carry little or no vegetation, the surface of the ground lying practically bare.

The chief communities are:—

1. *Zostera marina var. angustifolia Consocies.*

The dark-green long-leafed grass wrack occurs in the innermost zone with respect to the salt water bodies. Its extensive consocies gradually build up banks of clay and fine silt—the Zostereta of Warming (1909: 230). In the course of time these banks are raised still higher, until they allow of the entry of *Salicornia natalensis* and of *Cyanophyceae.*

In many places the Zostera is submerged at high tides, but to some extent exposed to the atmosphere at low. In others, the plant is always submerged.

That Zostera has a marked influence in the building up of banks and of meadows within a comparatively short time is evident from comparison of the charts of Knysna Harbour of 108 years ago‡ with those of to-day. Neglecting

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* The *Western Limit* is at *Harkerville Forest* (Muller's Hoek)—*vide* Diagram XXIX.

† *Vide* Maps.

‡ Surveyed by William Walker, R.N., 1818. Shown me by the late John Rex, Esquire, of Knysna, 1923. A copy is in the Clubroom of the Knysna Yacht Club.

disturbances caused by man, it is seen that quite extensive raised areas bearing Zostera and Salicornia exist to-day, where there was open water 108 years ago.

2. *Salicornia natalensis.*

The Marsh Samphire reacts upon the mud banks and flats colonized by zostera, so that these are steadily raised. As the period of exposure to the atmosphere increases, so does dominance of Zostera decrease.

Eventually Salicornia entirely ousts Sostera and forms consocies—the *Salicornieta* of Warming (1909 : 230).

Reference to the 108-year-old chart of the estuary of the Knysna reveals that portions submerged at high tides, and then bearing Salicornia natalensis, to-day are raised fields bearing Juncus maritimus, or field crops.

3. *Chenolea diffusa.*

The Salicornia consocies in time is invaded by Chenolea diffusa, which either forms smaller consocies within the former, or else mingles with it throughout the area and thus producing a *Salicornia-Chenolea associes.* These species continue to collect silt, and in this way to raise the level of the flats. Cyanophyceae are still frequent at this stage.

4. *Mixed communities* of Salicornia natalensis, Chenolea diffusa, Triglochin striatum, Scripus littoralis, Laurembergia repens, Cotula coronopifolia, and Juncus maritimus form the next stage. The level is higher and the soil drier than in the Salicornia-Chenolea associes.

Juncus maritimus often forms large consocies in the drier portions.

5. Sporobolus pungens, Cynodon dactylon, Stenotaphrum glabrum, and Juncus maritimus are the principal species of the zone exterior to the mixed community above-mentioned. The soil rarely receives salt water, and is much less moist and considerably less saline, than that of the mixed community. Samolus porosus, S. Valerandii, Aster ficoideus and Frankenia capitata may grow along with the grass and rush dominants.

6. The succession on silty portions passes to the stage of Semi-aquatics of the Hydrosere, and from this to climax macchia of stunted nature.

On sandy areas it develops Psammophilous Macchia, which in turn gives place to Psammophilous Scrub and Psammophilous Bush. This is an interesting example of initial stages of one sere at a certain point bifurcating* so that essentially different types of climaxes are produced.

The Psammosere.

Areas.—Sandy beaches, littoral dunes, sandy river beds, and in past ages sandy plateaux and basins.

The pioneer stages of the psammosere establish themselves on unstable, sandy surfaces, and by processes of sand-fixation, addition of organic and inorganic foods, and increase in moisture-content of the substratum, gradually bind together and enrich these surfaces.

In the region under study there is at the present day no very great development of the *earliest priseral* stages of the psammosere. Sandy beaches and duneland present the most extensive areas bearing these stages ; along the beds of most of the rivers and streams examples of the psammosere in its earliest stages are numerous, but the communities are of very limited extent. The areas available for development of the psammosere, in past ages must have been fairly large. Extensive portions along the strand proper and upon the first plateau probably were bare sandy wastes during very late Tertiary

* *Vide* Schematic Chart (Diagram XIV).

and early Recent Times—on these there are to-day semi-climax bush, sub-climax scrub, sub-climax bush, climax forest of coastal type, and Psammophilous Macchia. The white sands of the Knysna Series, lying on the first plateau and reaching portion of the second, to-day bear climax forest of very fair quality.

While the various stages described in the following account do occur in definite zonation in many instances, it is necessary to point out that in others there are various modifications introduced by changes in nature of locality, type of vegetation adjacent, supply of germules, and zoo-biotic associates.

For sake of clearness the psammosere developing on sands near the ocean will be treated separately from that developing along river valleys or elsewhere, inland. Several of the pioneer stages have much in common no matter where they be developed, but the ultimate stages, although distinctly related in certain respects, are widely different in others.

The succession on the coast will be described first :—

1. *Pioneers on periodically-tide-washed beach.*

Portions of the lower beach above high water mark are wave-washed during Spring or other exceptionally high tides ; such tides occur about from six to 12 times per annum. The beach may rise slightly as it proceeds inland, or may be flat. The winds pass too high above this portion of the beach to produce much drifting of the sand. The occasional high tides mentioned, together with spray borne inland from the breakers, assist in keeping the sand slightly damp at less than one inch below the surface.

Pioneer plants colonize portions of this zone :—

(a) *Salicornia fruticosa var. densifolia.*

This succulent xerophyte forms open consocies of small area. The plant attains an average height of twelve inches, and forms gnarled, woody branches of great strength. It shows no ill-effects after being inundated by sea water. Salicornia is a fairly efficient sand-fixer, but forms local hummocks that are swept away by very strong tides or by severe sea winds.

(b) *Sporobolus pungens.*

This wiry grass so widely distributed along the coast of South Africa and of other warm lands, is an important plant in this zone.

The creeping rhizomes are stoloniferous, and within a short time materially increase the area of the consocies, as well as decrease their openess. Eventually it produces hard, raised mounds, which resist the strongest tides and winds. Like Salicornia fruticosa, Sporobolus pungens is not sensitive to sea water ; consocies have been noted to grow in situations inundated several times per week, and yet to remain healthy and to extend their limits.

(c) *Scaevola Thunbergii E. & Z. (S. lobelia Murr.).*

This fleshy-leafed plant with its strong, abundantly-developed rhizomes, is a common pioneer in this zone. Regeneration is from seed, or vegetatively. Seedlings are often lesioned at the collars, should they be produced during warm, dry weather when the sand has been raised to temperatures of from 160–180 deg. Fahr. at its surface. During cooler weather the young plants readily establish themselves, and grow fast despite being half covered by sand. The Scaevola consocies are often many square yards in extent ; they form large hummocks, which at times are washed away by very high tides.

The plant is an excellent sand-fixer, and would be of great utility in drift-sand work were it not for its habit of hummock formation—these hummocks are scoured by the wind, and form weak spots in the artificial "littoral dune."

Sporobolus pungens and Hydrophylax carnosa sometimes associate with the Scaevola.

(d) *Hydrophylax carnosa.*

This procumbent, fleshy rubiaceous plant is abundant in certain portions of the coast, but is entirely absent from others. It forms very small, open consocies, and may, as above-mentioned, enter open communities of Scaevola and Sporobolus, in which it plays the role of a sub-dominant.

During exceedingly high seas much sand is tossed up, and the pioneer plants may either be torn from their situations or may be covered from several inches to as many feet in sand. Buried communities do not always succumb, for Scaevola and Sporobolus have really remarkable capacity for lying covered but visible for long periods; the ever-blowing sea breezes within several weeks usually uncover the buried plants.

Emphasis must be laid upon the extreme nature of this initial sandy habitat—severe insolation, strong and almost continually blowing winds, an atmosphere charged with salt, a substratum of innutritious sand often strongly saline, severe surface soil temperatures on clear, warm days throughout the year, and periodic drought in the upper layers. Such plants as Salicornia fruticosa, Sporobolus pungens, and Scaevola Thunbergii have well worked out the problem of capture and conversion of so extreme a habitat.

The periodically-tide-washed beach gradually yields way to that portion of the lower beach that never experiences salt water inundation, and this latter, to the upper beach and dunes.

2. *The Upper Beach and Sand Dunes.*

The upper beach and dunes are composed of dry sand much of which is kept in motion by sea and land breezes. The upper beach being considerably lower (from 10 to 30 feet elevation) than the dunes proper (from 50 to 200 feet), does not experience nearly as much wind as the latter.

While there is a general movement of the dunes inland, owing to the prevalence of the sea winds, there are minor movements in all directions owing to local wind currents and eddies. The steeper slopes of the dunes are to leeward, and despite the considerably less rough climatic conditions these slopes experience, often show smaller plant populations than do the windward slopes. The reasons for this are several: firstly, plants are better able to establish themselves and to spread on slopes of less intensity; secondly, there is a continual slipping downward of sand from above, on the leeward slopes, burying such pioneers as may have established themselves, wholly or in part; thirdly, it is often found that the moisture-content of the sand at levels of from six to twelve inches on the windward slopes is greater than that at equivalent depths on the leeward, the differences being more marked if the latter experience northern or north-western aspects. Pioneer communities, however, are found in greatest numbers and in the most luxuriant condition in the hollows at the bases of the dunes on their leeward sides. Such hollows enjoy better soil-moisture conditions—through seepage from the dunes—and better protection from wind and insolation than do any other portions of the upper beach and younger dunes. Owing to the scouring action of the local breezes and of the stronger land winds, such hollows are gradually increased in extent, and are colonized by pioneer plants as they extend.

From such centres of plant life there advance colonizing forces that invade the steep lee slopes of the dunes and slowly but surely capture ground. Unless the dune in question happens to be particularly unstable, the gradual fall of sand from above is not sufficient to inhibit the establishment and growth of the more assertive members of the invading pioneers. Such species as Cryptostemma niveum, Ficinia lateralis, Eragrostis cyperoides, E. glabrata, Mariscus congestus, Stenotaphrum glabrum, Mesembryanthemum edule, Tetragonia decumbens, Solanum aggerum, S. nigrum (sea form), Scaevola

Thunbergii, and Myrica cordifolia, are persistent invaders. At a later stage Cussonia thyrsiflora, Stoebe cinerea, Rhus crenata, Restio Eleocharis Eriocephalus umbellatus, E. capitellatus, Salvia aurea, Sutherlandia frutescens, and Passerina rigida, are frequently found as invaders.

Very unstable dunes, however, allow of no colonization of their slopes, and advance upon any hollows that may occur at their bases, thus killing out the few pioneers that may have established themselves.

Through disturbance caused by man and his animals there is a tendency for the dunes in certain localities to advance upon the macchia and scrub inland, and to destroy pasture and arable land.

The introduction by the Forest Department of a modification of the famous Bremontier* system of dune-fixation, at Buffalo Bay is already producing good results. The exotic Marram (Ammophila arundinacea)† has been planted at the Bay and also on Knysna Western Head as well as at the Zitzikamma drift sands, with the result that the plant is spreading naturally. Certain indigenous psammophytes and macchia plants are being employed with promising results.

The principal features of the vegetation of the upper beach and dunes are described below.

The periodically-tide-washed beach gradually yields way to that portion of the lower beach that never experiences salt water inundation and this latter, to the upper beach and dunes.

3. *Vegetation of the Upper Beach and Sand Dunes.*

Scaevola Thunbergii and Sporobolus pungens are to be found in this zone, forming larger and stronger consocies and associes than they do in the first described zone. They may be associated with one or more of the species described below.

(a) *Eragrostis cyperoides.*

This perennial, slightly ascending or erect grass with its lengthy creeping rhizomes is a common plant of this zone. It forms consocies and also forms associes with Stenotaphrum glabrum, Eragrostis glabrata, Ehrharta spp., and Sporobolus pungens.

(b) *Stenotaphrum glabrum.*

Stenotaphrum glabrum is a prostrate grass forming strong consocies on the beach as well as far inland. When abundant it builds up a dense, hard carpet and prevents the establishment of any but very assertive species. As a co-dominant or sub-dominant it is found in most of the communities of this zone.

(c) *Mesembryanthemum edule.*‡

The " T'gaukaum," or " Zuurvij," a fleshy prostrate forms dense consocies of frequent occurrence. The spread of the species is rapid, being accomplished vegetatively as well as by seeds. Owing to the fruits being edible, man and apes have much assisted in its dispersal. M. edule has marked capacity for fixing the unstable sand, and has been employed extensively in drift-sand fixation work.

(d) *Cryptostemma* (*Microstephium*) *niveum.*

" Gousblom " with its densely canescent, fleshy foliage and white prostrate stems, develops extensive, flat consocies that show little open ground in their

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* *Bremontier*, a French engineer, in 1778 published a treatise concerning the fixation of sand dunes by planting grasses.

† *Psamma arenaria* Beau.

‡ *M. pugioniforme* sometimes occurs with H. edule.

older portions. The plant spreads rapidly by vegetative means as well as by its wind-borne seeds. In common with Sporobolus and Scaevola it can withstand lengthy burial.

Its trial in drift-sand fixation is urged.

(e) *Ipomaea biloba Forsk.*

The "Wild Sweet Potato" is a common species in some localities but is rare in others. It forms fairly close consocies or may form associes with Scaevola, the various grasses already mentioned, and less often with Mesembryanthemum edule. The plant is a rapid spreader and an efficient sand binder worthy of some attention in drift-sand practice. It grows readily from cuttings and is easily produced from seed.

(f) *Myrica cordifolia.*

The "Waxberry" is one of the most important sand-fixers along South African coasts. It is a ligneous shrub, seldom erect in habit, usually procumbent or sub-prostrate, its abundantly-developed branches spreading over the sand. The height of the plant may vary from eight inches to over thirty-six, but the average height is about twelve inches.

The species forms strong consocies of considerable extent; other species often are associated with it, either as co- or sub- dominants. Its communities form the medium for the development of either Psammophilous Scrub or Psammophilous Macchia. Associated species commonly found with Myrica cordifolia are Solanum aggerum, S. quadrangulare, Rhus crenata, Passerina rigida, Tetragonia fruticosa, T. decumbens, Mesembryanthemum spp., and Scaevola Thunbergii, besides the Psammophilous grasses already mentioned as occurring on the beach. Mariscus congestus and Ficinia lateralis are also found occasionally. Myrica quercifolia occasionally grows with M. cordifolia, and on older dunes, M. conifera is an associate.

M. cordifolia produces abundant fruits; study of these by J. F. Phillips* has shown that they require from 6 to eighteen months for germination unless the waxy covering is removed and the endocarp is softened by chemicals such as dilute sulphuric acid or dilute sodium hydroxide. *About* 40 *per cent. of the annual crop is fertile*, but only a very small number of the fertile fruits germinates. Seedlings are lesioned to death by the high temperature on clear, warm days.

Propagation by "layering" is possible if the operation be carried out with due care.

The species reacts strongly upon the sandy substratum, adding much litter, and much food material organic and inorganic, as well as binding the loose sandy particles so as to form a more stable soil.

(g) *Tetragonia spp.* (Aizoaceae).

Tetragonia decumbens, T. spicata, and T. fruticosa are found frequently, either in small consocies or in small associes; they also mingle with other dune species. The first two spp. are fleshy prostrates, the third, fleshy, erect, and shrubby. The Tetragonia spp. form moderately close communities which effectively hold the sand.

Their fruits are winged, and being borne in profusion are dispersed far and wide. Germination and establishment, however, do not appear highly successful, few seedlings being observed.

(h) *Passerina rigida Wikstr.*

This ericoid plant of the Thymeleaceae possesses small, lanceolate leaves closely adpressed to a densely woolly-pubescent straight woody stem. It

* Unpublished nursery-practice notes, 1923-24.

assumes heights varying from twelve inches to 48, according to locality, and forms consocies usually close in nature and extensive in area. The species is rarely found in the macchia and scrub of the older dunes, its favoured locality being the unfixed dunes or the upper limits of the beach. Associated with P. rigida may be Rhus crenata, Restio Eleocharis, Solanum aggerum, Erica speciosa, and Metalasia muricata, as well as any of the other species mentioned as occurring in the zone under description.

P. rigida is a firm sand binder, and forms embryo dunes, but does not add much humus to the substratum on account of its leaves being minute and long persistent.

The anemophilous flowers are produced in great profusion, but as the fruits are few and of low fertility, the species does not spread rapidly.

Occasionally mingling with P. rigida and scarcely to be distinguished from it vegetatively, is P. vulgaris Thod.

(i) *Chironia baccifera.*

"Schildpadbesje," bearing its profuse array of pink flowers at almost any time of the year, forms dense consocies in the form of "tussocks," from twelve inches to twenty-four inches in height, and several yards in area.

The fixing and humus-adding capacities of the plant are considerable.

It spreads readily by seeds which are produced in large numbers and are bird-dispersed.

(j) *Stoebe cinerea.*

A stunted form of Stoebe cinerea is frequent on the upper dunes, its untidy, ericoid branches spreading far over the sand.

It is often found in consocies but also occurs in associes, with Metalasia and Eriocephalus as co-dominants.

(k) *Metalasia muricata.*

"Blombos," a densely-branched, sclerophyllous, woody shrub varying in height from six inches to 10 feet, is widely distributed along the South African coasts. It forms very extensive and important sand-fixing, soil-improving consocies, and also occurs as a co-dominant in various associes with such species as Passerina rida, P. vulgaris, Erica speciosa, Stoebe cinerea, Osteospermum spp.

There are several distinct varieties of the species which occur on the plateaux, and in the mountains, as well as on the coast.

The commoner coastal varieties are *var. phylicoides Don.*, and *var. obtusiuscula Harv.*

(l) *Erica speciosa.*

On the upper portions of the beach and in various more sheltered positions among the dunes themselves, grows the hardy stunted form of E. speciosa. The plant sometimes occurs in consocies, but usually in association with Stoebe cinerea and Metalasia. It is an important fixer and sand-improver, but is slow in extending its limits and in putting on height growth. It seeds profusely, but few of the seedlings ever reach adult size. A severe *Capnodium* disease attacks and kills off large numbers of the shrubs.

(m) Near water courses, where the sand contains more moisture, and at the bases of windward and leeward slopes of dunes, occur Scirpus nodosus, Mariscus congestus, and Ficinia lateralis, although the last named plant also occurs on much drier sites.

Scirpus nodosus forms marked consocies, the characteristic tussocks being very dense within, but are separated from each other by open sand which may become colonized by Sporobolus, Stenotaphrum, or Mariscus. Mariscus builds very open, straggling consocies, but effectively holds the soil in position by means of its widely-spreading roots. Ficinia lateralis does not grow in definite communities, but is scattered over most of the upper beach.

(4) *Very mixed communities consisting of most of the species already described as occurring on the upper beach and dunes*, form a transition stage to Psammophilous Macchia. Associated with these species are the following:—

Ehrharta brevifolia, E. calycina, E. villosa, Cynodon dactylon, Agropyrum distichum (exotic), Salvia aurea, Sutherlandia frutescens, Psoralea bracteata, Heliophila spp., Statice scabra, Silene Burchellii, S. capensis, S. primulaeflora, Geranium incanum, G. ornithopodum, Pelangonium zonale, P. reniforme, P. capitatum, P. iocastrum, Helichrysum teretifolium, H. cymosum, H. nudifolium, H. rosum, H. rugulosum, H. ericaefolium, Felicia echinata, Aster capensis, Vernonia anisochaetoides, Disparago ericofides, Cryptostemma calendulaceum, Cephalaria attenuata, Solarium rigescens, Cotyledon orbiculata, Crassula expansa, and many others. These mixed communities play an important role in fixation and improvement processes, and to a very great extent prepare the soil for the carrying of Macchia.

(5) *Psammophilous Macchia.*

The mixed transition stage described above merges into Psammophilous Macchia, an extensive community clothing the upper dunes and portions of the first plateau for a mile or more inland. This type of macchia differs from others in that it occurs on white or grey sand derived from the ocean, possesses certain floristic features peculiar to it, and is much gnarled, twisted, and stunted as the result of wind action. The community, while varying considerably floristically according to locality, has the same physiognomy throughout. In the more extreme localities the macchia remains the climax community, especially if the supply of germules by scrub and bush species be poor. On better favoured sites climatically and edaphically—and receiving a fair supply of scrub and bush germinules—the macchia develops into scrub or bush.

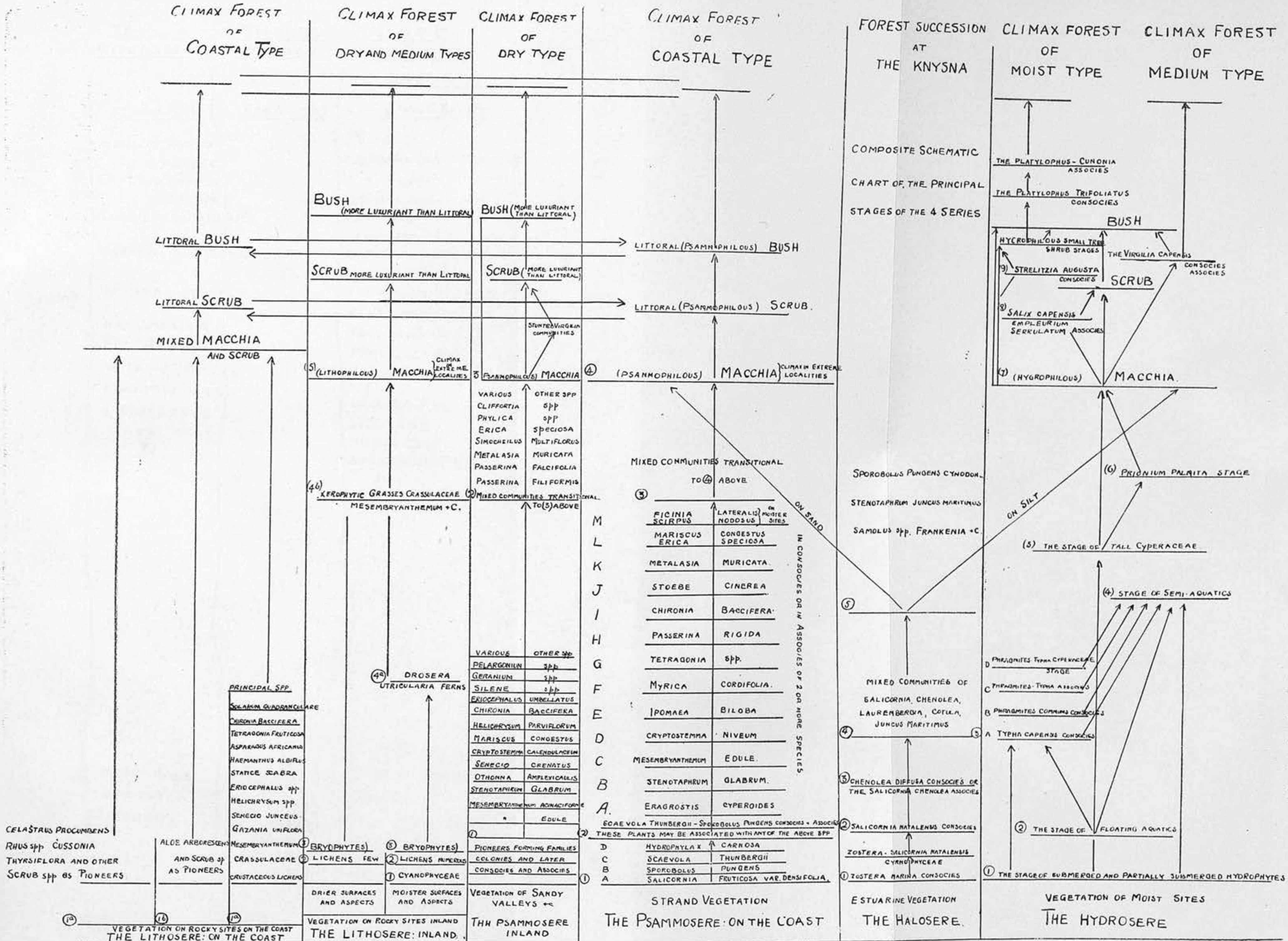
Psammophilous Macchia on the dunes and lower portions of the first plateau, experiences comparatively severe habitat conditions: exposure to continually-blowing winds often of great strength; high degree of insolation on clear days all the year round; a rainfall lower (by from ten to twenty inches per annum), than that of the first and second plateaux; a chemically-poor soil.

A general account of the principal floristic and sociological features only, is given here:—

The height of the community varies from 12 inches to over 72, but the average is about 36 inches. In portions the covering is exceedingly dense owing to the shrubby, much branched nature of the constituent plants, but in others open areas exist, populated by the prostrate Stenotaphrum glabrum, and less often by Restio Eleocharis. Brunsvigia gigantea occurs sparingly in such opener portions.

The most important part in the structure of the Macchia is played by woody shrubs, such as Metalasia muricata, Osteospermum moniliferum, O. corymbosum, Phylica lasiocarpa, P. spp., Erica speciosa, E. spp., Cliffortia falcifolia, C. filifolia, Psoralea spp., Aspalathus spp., Passerina vulgaris, and Barosma scoparia, the smaller woody plants and herbs playing a subordinate role.

Metalasia muricata in its several coastal varieties is present in extensive consocies, and is a co-dominant in associes where Erica speciosa, Phylica lasiocarpa, Osteospermum spp., are well represented. Associated plants of importance in such communities are: Erica sessiliflora, E. curviflora, E. diaphana, E. chloroloma, E. decipiens, E. peltata, E. maesta, E. glumaefolia,


CLIMAX FOREST OF COASTAL TYPE
CLIMAX FOREST OF DRY AND MEDIUM TYPES
CLIMAX FOREST OF DRY TYPE
CLIMAX FOREST OF COASTAL TYPE
FOREST SUCCESSION AT THE KNYSNA
CLIMAX FOREST OF MOIST TYPE
CLIMAX FOREST OF MEDIUM TYPE
COMPOSITE SCHEMATIC CHART OF THE PRINCIPAL STAGES OF THE 4 SERIES
BUSH (MORE LUXURIANT THAN LITTORAL)
BUSH (MORE LUXURIANT THAN LITTORAL)
LITTORAL BUSH
LITTORAL (PSAMMOPHILOUS) BUSH
SCRUB MORE LUXURIANT THAN LITTORAL
SCRUB (MORE LUXURIANT THAN LITTORAL)
LITTORAL SCRUB
LITTORAL (PSAMMOPHILOUS) SCRUB.
STUNTED VIRGILIA COMMUNITIES
MIXED MACCHIA AND SCRUB
(5) (LITHOPHILOUS) MACCHIA CLIMAX IN EXTREME LOCALITIES
5 PSAMMOPHILOUS MACCHIA
(4) (PSAMMOPHILOUS) MACCHIA CLIMAX IN EXTREME LOCALITIES
THE PLATYLOPHUS - CUNONIA ASSOCIES
THE PLATYLOPHUS TRIFOLIATUS CONSOCIES
BUSH
HYGROPHILOUS SMALL TREE SHRUB STAGES
THE VIRGILIA CAPENSIS CONSOCIES ASSOCIES
(9) STRELITZIA AUGUSTA CONSOCIES
SCRUB
(8) SALIX CAPENSIS EMPLEURUM SERRULATUM ASSOCIES
(7) (HYGROPHILOUS) MACCHIA.
VARIOUS CLIFFORTIA PHYLICA ERICA SIMOCHEILUS METALASIA PASSERINA PASSERINA
OTHER SPP SPP SPP SPECIOSA MULTIFLORUS MURICATA FALCIFOLIA FILIFORMIS
MIXED COMMUNITIES TRANSITIONAL TO (4) ABOVE
(4b) XEROPHYTIC GRASSES CRASSULACEAE MESEMBRYANTHEMUM + C.
(2) MIXED COMMUNITIES TRANSITIONAL TO (5) ABOVE
(3)
FICINIA LATERALIS (ON MOISTER SITES)
SCIRPUS NODOSUS
MARISCUS CONGESTUS
ERICA SPECIOSA
METALASIA MURICATA
STOEBE CINEREA
CHIRONIA BACCIFERA
PASSERINA RIGIDA
TETRAGONIA SPP.
MYRICA CORDIFOLIA
IPOMAEA BILOBA
CRYPTOSTEMMA NIVEUM
MESEMBRYANTHEMUM EDULE
STENOTAPHRUM GLABRUM
ERAGROSTIS CYPEROIDES
M L K J I H G F E D C B A
IN CONSOCIES OR IN ASSOCIES OF 2 OR MORE SPECIES
ON SAND
ON SILT
SPOROBOLUS PUNGENS CYNODON. STENOTAPHRUM JUNCUS MARITIMUS SAMOLUS SPP. FRANKENIA + C.
(6) PRIONIUM PALMITA STAGE
(5) THE STAGE OF TALL CYPERACEAE
(4) STAGE OF SEMI-AQUATICS
(5)
D PHRAGMITES TYPHA CYPERACEAE STAGE
C PHRAGMITES - TYPHA ASSOCIES
B PHRAGMITES COMMUNIS CONSOCIES
(3) A TYPHA CAPENSIS CONSOCIES
MIXED COMMUNITIES OF SALICORNIA, CHENOLEA, LAURENBERGIA, COTULA, JUNCUS MARITIMUS
(4)
(3) CHENOLEA DIFFUSA CONSOCIES OR THE SALICORNIA CHENOLEA ASSOCIES
(2) SALICORNIA NATALENSIS CONSOCIES
ZOSTERA - SALICORNIA NATALENSIS CYANOPHYCEAE
(1) ZOSTERA MARINA CONSOCIES
(2) THE STAGE OF FLOATING AQUATICS
(1) THE STAGE OF SUBMERGED AND PARTIALLY SUBMERGED HYDROPHYTES
(4a) DROSERA UTRICULARIA FERNS
PRINCIPAL SPP
SOLANUM QUADRANGULARE
CHIRONIA BACCIFERA
TETRAGONIA FRUTICOSA
ASPARAGUS AFRICANUS
HAEMANTHUS ALBIFLOS
STATICE SCABRA
ERIOCEPHALUS SPP
HELICHRYSUM SPP.
SENECIO JUNCEUS
GAZANIA UNIFLORA
MESEMBRYANTHEMUM
CRASSULACEAE
CRUSTACEOUS LICHENS
VARIOUS OTHER SPP
PELARGONIUM SPP
GERANIUM SPP
SILENE SPP
ERIOCEPHALUS UMBELLATUS
CHIRONIA BACCIFERA
HELICHRYSUM PARVIFLORUM
MARISCUS CONGESTUS
CRYPTOSTEMMA CALENDULACEUM
SENECIO CRENATUS
OTHONNA AMPLEXICAULIS
STENOTAPHRUM GLABRUM
MESEMBRYANTHEMUM ACINACIFORME
EDULE
(1)
SCAEVOLA THUNBERGII - SPOROBOLUS PUNGENS CONSOCIES + ASSOCIES
(2) THESE PLANTS MAY BE ASSOCIATED WITH ANY OF THE ABOVE SPP
D HYDROPHYLAX CARNOSA
C SCAEVOLA THUNBERGII
B SPOROBOLUS PUNGENS
(1) A SALICORNIA FRUTICOSA VAR. DENSIFOLIA.
CELASTRUS PROCUMBENS
RHUS SPP CUSSONIA
THYRSIFLORA AND OTHER
SCRUB SPP AS PIONEERS
ALOE ARBORESCENS AND SCRUB SP AS PIONEERS
(3) BRYOPHYTES
(2) LICHENS FEW
(5) BRYOPHYTES
(2) LICHENS NUMEROUS
(1) CYANOPHYCEAE
DRIER SURFACES AND ASPECTS
MOISTER SURFACES AND ASPECTS
PIONEERS FORMING FAMILIES COLONIES AND LATER CONSOCIES AND ASSOCIES
VEGETATION OF SANDY VALLEYS
STRAND VEGETATION
ESTUARINE VEGETATION
VEGETATION OF MOIST SITES
(1a) (1b) (1c)
VEGETATION ON ROCKY SITES ON THE COAST
THE LITHOSERE: ON THE COAST
VEGETATION ON ROCKY SITES INLAND
THE LITHOSERE: INLAND
THE PSAMMOSERE INLAND
THE PSAMMOSERE: ON THE COAST
THE HALOSERE.
THE HYDROSERE

	SUBMERGED AND PARTIALLY SUBMERGED HYDROPHYTES		SEMI AQUATICS.	TALL CYPERACEAE	PRIONIUM PALMITA	HYGROPHILOUS MACCHIA
WATER OF STREAM OR VLEI	STAGE (1) eg. CHARA POTAMOGETON FLUITANS, CERATOPHYLLUM DEMERSUM, MYRIOPHYLLUM SPICATUM, UTRICULARIA EXOLETA, LAGAROSIPHON MUSCOIDES CRASSULA INANIS. ALSO FLOATING AQUATICS STAGE (2) eg APONOGATON DISTACHYON, NYMPHAEA STELLATA, LIMNANTHEMUM THUNBERGIANUM	STAGE (3A) TYPHA CAPENSIS CONSOCIES AND STAGE (3B) PHRAGMITES COMMUNIS CONSOCIES AND STAGE (3C) PHRAGMITES-TYPHA ASSOCIES AND STAGE (3D) PHRAGMITES-TYPHA-CYPERACEAE STAGE.	STAGE (4). eg. CYPERACEAE, HYGROPHILOUS GRAMINEAE, " " RESTIACEAE " " ORCHIDACEAE ZANTEDESCHIA AETHIOPICA WACHENDORFIA THYRSIFLORA KNIPHOFIA SPP, LAUREMBERGIA, RANUNCULUS PINNATUS ILYSANTHES RIPARIA COTULA, VILLARSIA	STAGE (5) eg MARISCUS RIPARIUS " CONGESTUS CYPERUS IMMENSUS " TEXTILIS CLADIUM TAMACIENSE CARPHA GLOMERATA SCIRPUS LITTORALIS AND SMALLER CYPERACEAE ALSO JUNCUS LOMATOPHYLLUS J. OXYCARPUS &c.	STAGE (6)	STAGE (7) eg HYGROPHILOUS RESTIACEAE " CLIFFORTIA spp. BRUNIA NODIFLORA BERZELIA SPP, ERICA spp BARUSMA SCOPARIA EMPLEURUM, PSORALEA PINNATA CLUYTIA spp. POLYGALA spp. PROTEACEAE ORCHIDACEAE, LILIACEAE, IRIDACEAE, AMARYLLIDACEAE. &c.
	MUD, OOZE, RAW LITTER INUNDATED.	ORGANICALLY-RICH, SILTY SOIL; PARTIALLY AND PERIODICALLY INUNDATED.	LITTLE OR NO FREE WATER INCREASED STABILIZATION OF SOIL: PERIODICALLY INUNDATED	MORE BODY. LESS OFTEN FLOODED.	AS IN (5)	MUCH IMPROVED SOIL - BUT STILL MOIST AND ACID

DIAGRAM: TYPICAL ZONATION: INITIAL STAGES OF THE HYDROSERE

XVI.

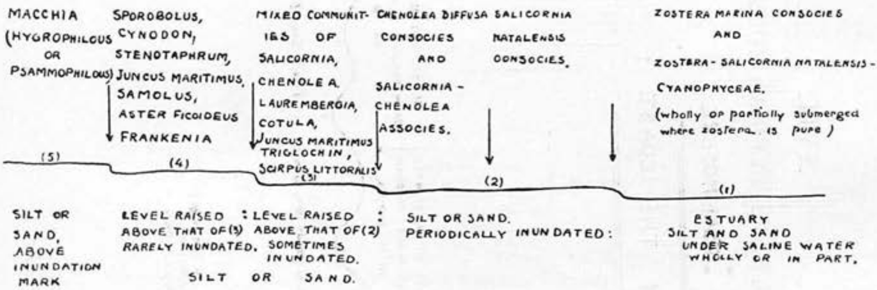


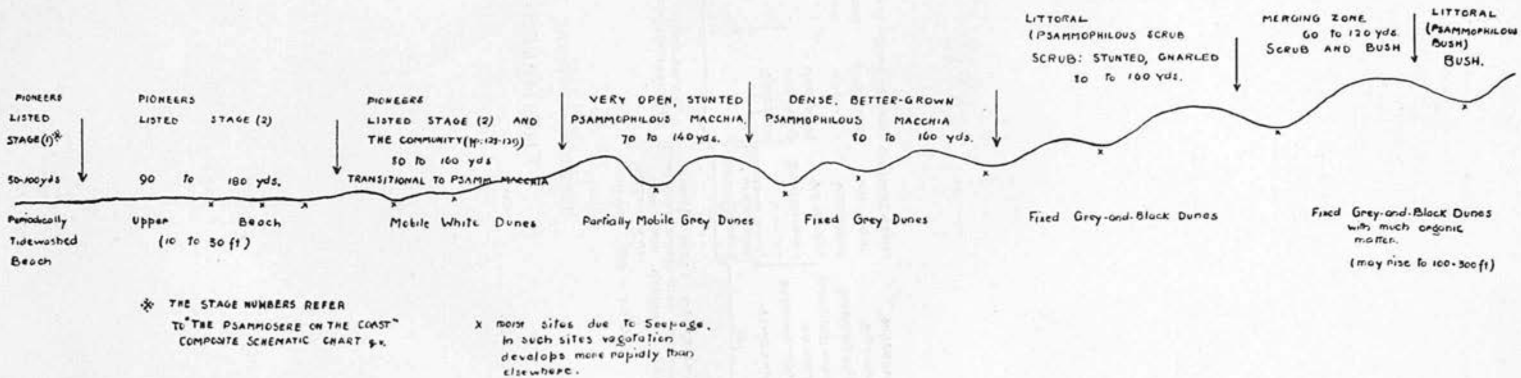
DIAGRAM: TYPICAL ZONATION

THE HALOSERE.

XVII.

DIAGRAM: TYPICAL ZONATION.

THE PSAMMOSERE ON THE COAST.

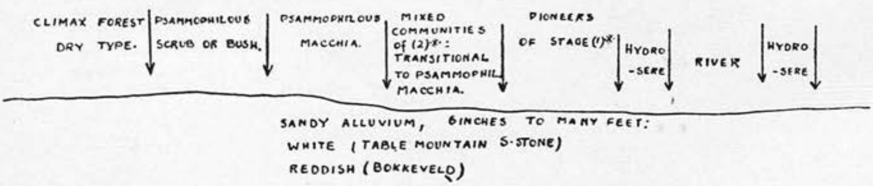


XVIII.

DIAGRAM: TYPICAL ZONATION

THE PSAMMOSERE

INLAND.



※ NUMBERS REFER TO "THE PSAMMOSERE INLAND" COMPOSITE SCHEMATIC CHART – q.v.

XIX.

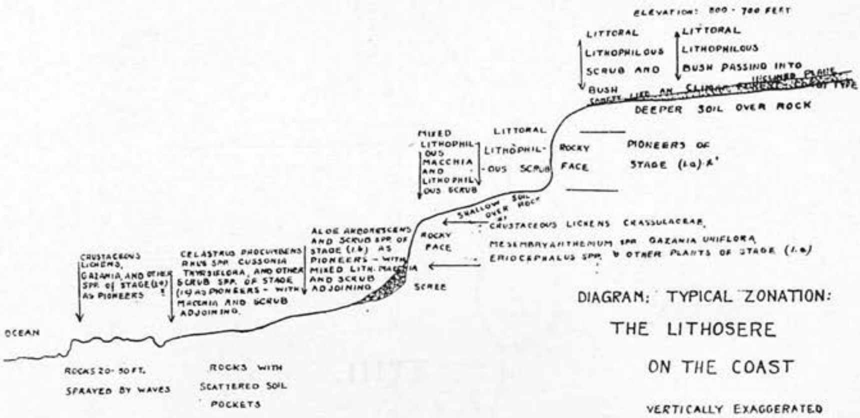


DIAGRAM: TYPICAL ZONATION:

THE LITHOSERE

ON THE COAST

VERTICALLY EXAGGERATED

* NUMBERS REFER TO "THE LITHOSERE ON THE COAST" COMPOSITE SCHEMATIC CHART 9"

XX.

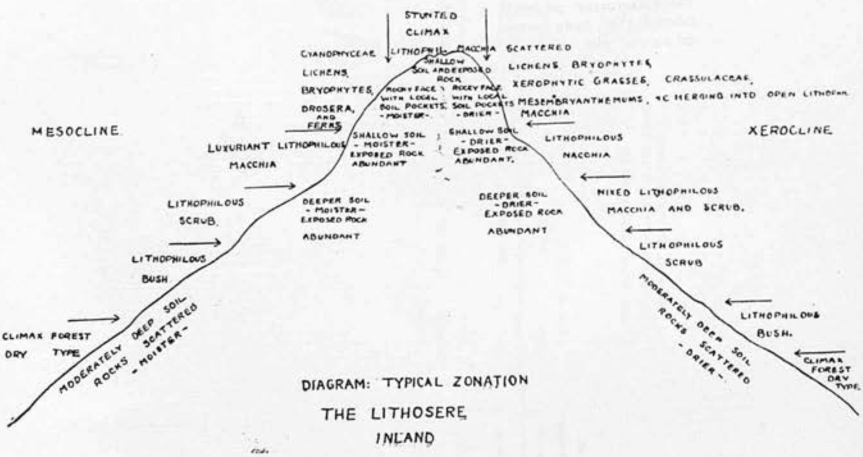
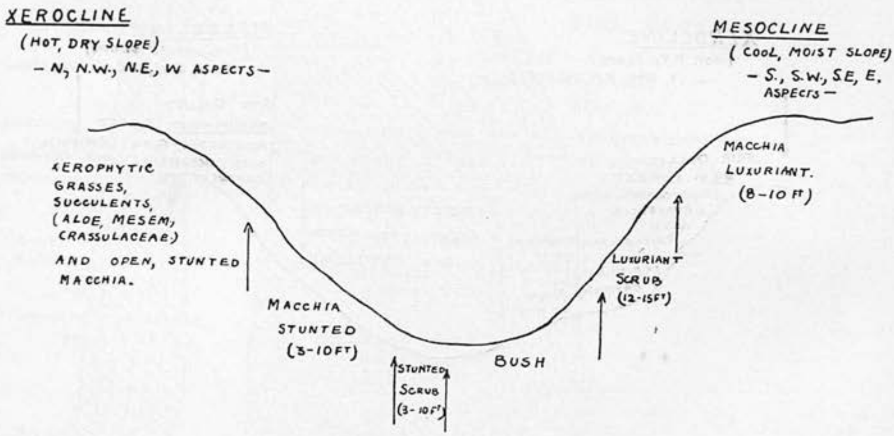


DIAGRAM: TYPICAL ZONATION

THE LITHOSERE

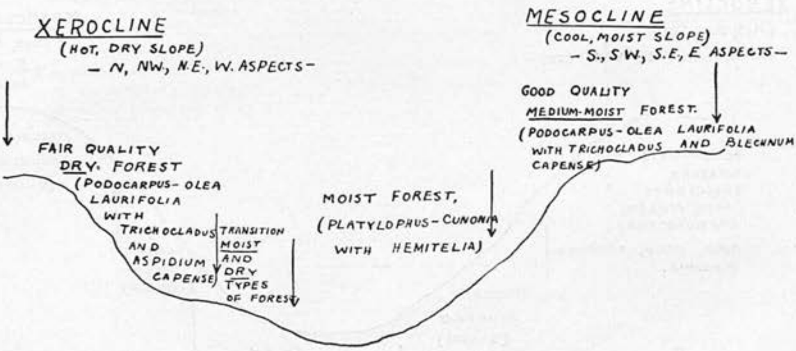
INLAND

XXI.



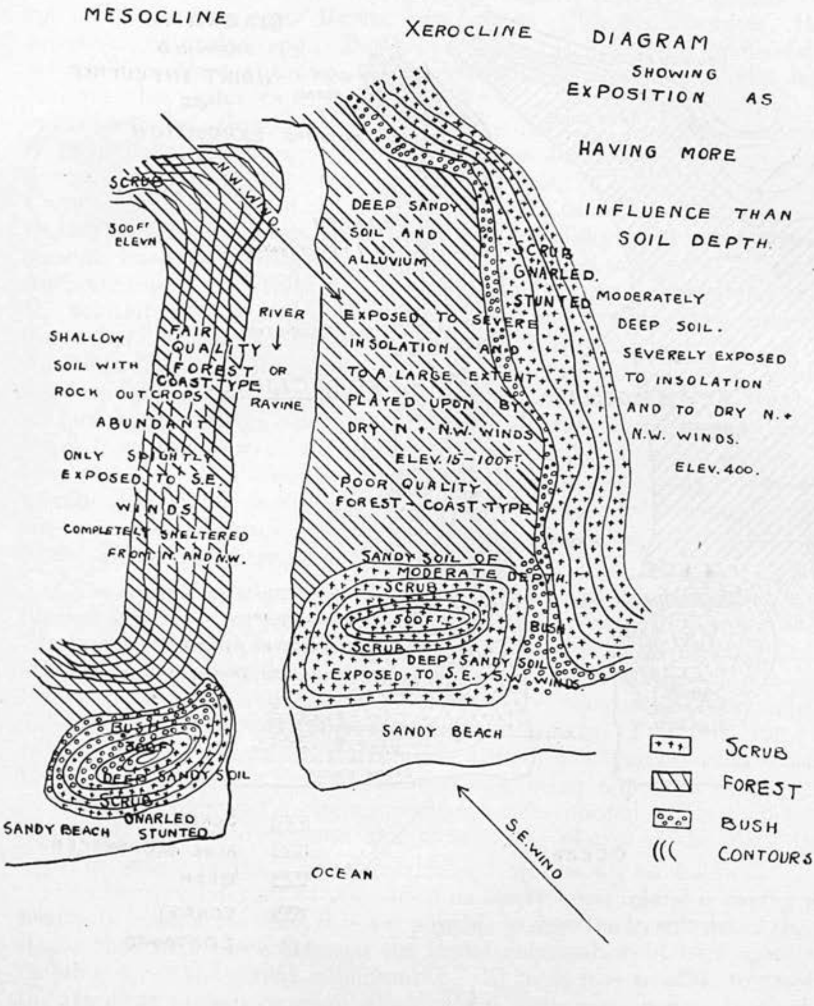
DIAGRAMMATIC EXAMPLE OF THE INFLUENCE OF ASPECT (EXPOSITION) UPON MEDIAL SUCCESSIONAL STAGES. — GEOLOGICAL FORMATION (T.M.S) AND SOIL THE SAME.

XXII.



DIAGRAMMATIC EXAMPLE OF THE INFLUENCE OF ASPECT (EXPOSITION) UPON PENULTIMATE AND ULTIMATE STAGES. GEOLOGICAL FORMATION AND SOIL THE SAME.

XXIII.



MESOCLINE
XEROCLINE
DIAGRAM
SHOWING
EXPOSITION AS
HAVING MORE
INFLUENCE THAN
SOIL DEPTH.
SCRUB
300 FT ELEVN
N.W. WIND
DEEP SANDY SOIL AND ALLUVIUM
SCRUB GNARLED. STUNTED
MODERATELY DEEP SOIL.
SEVERELY EXPOSED TO INSOLATION AND TO DRY N. + N.W. WINDS.
ELEV. 400.
RIVER
RAVINE
SHALLOW SOIL WITH ROCK OUTCROPS ABUNDANT
FAIR QUALITY FOREST OR COAST TYPE
EXPOSED TO SEVERE INSOLATION AND TO A LARGE EXTENT PLAYED UPON BY DRY N. + N.W. WINDS
ELEV. 15 – 100 FT.
ONLY SLIGHTLY EXPOSED TO S.E. WINDS.
COMPLETELY SHELTERED FROM N. AND N.W.
POOR QUALITY FOREST – COAST TYPE
SANDY SOIL OF MODERATE DEPTH.
SCRUB
500 FT.
SCRUB
BUSH
DEEP SANDY SOIL
EXPOSED TO S.E. + S.W. WINDS.
BUSH
300 FT
DEEP SANDY SOIL
SCRUB.
GNARLED STUNTED
SANDY BEACH
SANDY BEACH
OCEAN
S.E. WIND
SCRUB
FOREST
BUSH
CONTOURS

XXIV.

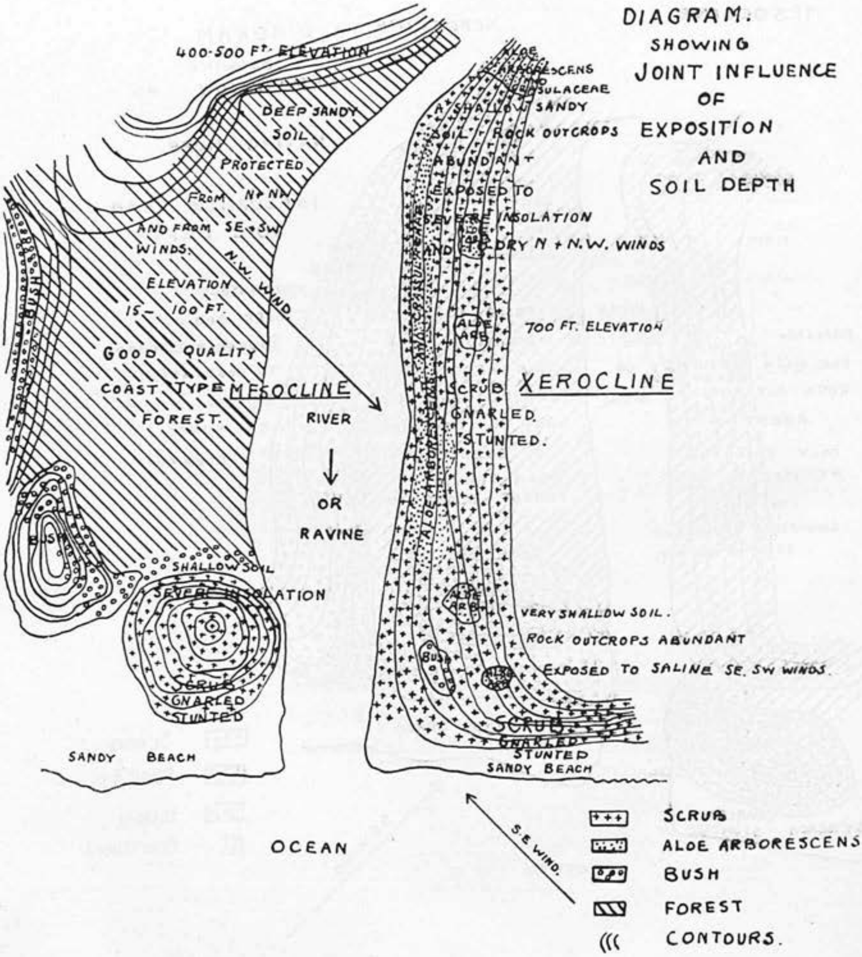


DIAGRAM.
SHOWING
JOINT INFLUENCE
OF
EXPOSITION
AND
SOIL DEPTH
400-500 FT. ELEVATION
DEEP SANDY
SOIL
PROTECTED
FROM N + NW
AND FROM SE + SW
WINDS.
N.W. WIND
ELEVATION
15.- 100 FT.
GOOD QUALITY
COAST TYPE MESOCLINE
FOREST.
BUSH
RIVER
OR
RAVINE
SHALLOW SOIL
SEVERE INSOLATION
SCRUB
GNARLED
STUNTED
SANDY BEACH
ALOE
ARBORESCENS
A SHALLOW SANDY
SOIL ROCK OUTCROPS
ABUNDANT
EXPOSED TO
SEVERE INSOLATION
AND DRY N + N.W. WINDS
700 FT. ELEVATION
SCRUB XEROCLINE
GNARLED
STUNTED.
VERY SHALLOW SOIL.
ROCK OUTCROPS ABUNDANT
EXPOSED TO SALINE SE. SW WINDS.
SCRUB
GNARLED
STUNTED
SANDY BEACH
OCEAN
S.E. WIND.
SCRUB
ALOE ARBORESCENS
BUSH
FOREST
CONTOURS.

Printzia Bergii, Indigofera procumbens, I. sulcata, I. stricta, I. poliotes, I. disticha, Rhynchosia leucoscias, R. adenodes, R. carribea, Argyrolobium Andrewsianum, A. collinum, Sutherlandia frutescens, Psoralea bracteata, P. tomentosa, P. pinnata, P. axillaris, Podalyria cuneifolia, Aspalathus ciliaris, A. Benthami, A. ericifolia, A. canescens, A. setacea, A. spinosa, Borbonia lanceolata, Silene capensis, S. Burchellii, S. primulaeflora, Muraltia ericaefolia, M. alopecuroides, M. satureoides, M. squarrosa var. ruscifolia, Zygophyllum fulvum, Z. morgsana, Z. flexuosa, Cardamine africana, Heliophila linearifolia, H. spp., Lepidium decumbens, Passerina vulgaris (rarely P. rigida), Geranium spp., Pelargonium spp., Bubon hypoluceum, Chironia baccifera, Habenaria arenaria, Satyrium spp., Bartholina spp., Helichrysum paniculatum, H. teretifolium, H. maritimum, H. nudifolium, H. rosum, Pteronia incana, P. baccharoides, Aster capensis, A. affinis, A. echinatus, A. hispidus, Vernonia anisochaetoides, Gazania uniflora, Stoebe cinerea, Eriocephalus umbellatus, E. capitellatus, Disparago ericoides, Cullumia decurrens, Cephalaria attenuata, Senecio arnicaefolia, S. crenatus, S. ilicifolius, S. purpureus, S. cordifolius, Ursinia filicaulis, Othonna amplexicaulis, O. carnosa, Athanasia dimorpha, Oedera latifolia, Relhania quinquinervis, R. sessiliflora, Cryptostemma calendulaceum, Barosma lanceolata, Agathosma, ciliata, A. apiculata, A. microphylla, Anthospermum prostratum, A. aethiopicum, Mesembryanthemum edule, M. acinaciforme, M. spp. (both prostrate and fruticose), Tetragonia spp., Cotyledon orbiculata, Crassula ericoides, Ehrharta brevifolia, E. villosa, Themeda triandra, Eragrostis glabrata, Stenotaphrum glabrum, Ficinia spp., Tetraria spp., Mariscus congestus, and several species of Restio, Elegia, Thamnochortus, and Dovea. Several of the species listed form consocies and associes apart from the general mixed type of community described above: notable examples are: Passerina vulgaris, Phylica lasiocarpa, Osteospermum moniliferum, Erica sessiliflora, E. cerviflora, Eriocephalus capitellatus, Stoebe cinerea, Stenotaphrum glabrum, Restio Eleocharis, Mesembryanthemum edule, M. acinaciforme, and M. knysnanum.

The Psammophilous Macchia leading to Scrub shows presence of such species as: Royena pallens, R. glabra, Rhus crenata, R. lucida, R. villosa, Tarchonanthus camphoratus (stunted form), Buddleia salviaefolia, Chilianthus arboreus, Myrica conifera, Celastrus (Gymnosporia) buxifolius, Carissa arduina, Rhamnus prinoides, Grewia occidentalis, Olea exasperata (O. humilis Eckl.), Sideroxylon inerme, and often Celastrus acuminatus, Pterocelastrus variabilis var. variabilis, and the semi-prostrate Celastrus (Gymnosporia) procumbens. The Scrub shrubs are usually far scattered, being separated from each other by Macchia taller and more luxuriant than the normal. The tendency is for the Scrub species to increase and to oust the plants of the Macchia.

The stages of the Psammosere inland are usually as follows:

As the development of vegetation on sandy areas inland is taking place on relatively small areas only, it is not possible to describe in any detail the various stages that take place between the initial colonization of bare areas and the building up of the climax communities. At most it is possible to trace briefly the stages at present represented along the larger river beds. It is, of course, extremely likely that these small communities reflect faithfully in miniature the general processes that must have taken place on a grand scale in past ages.

Areas: Sandy river beds.

Along some of the larger rivers there exist areas of pure quartz sand derived by erosive processes from the Table Mountain sandstone, as well as from such Bokkeveld beds as may occur along the valleys. The length of such deposits may be many miles, the width seldom 100 yards, the depth from 6 inches to many feet.

The sand possesses little or no clay or silt, and scarcely any organic matter; the water-content is usually low, except near the banks of the rivers. Owing to their lying in valleys, in which there is slight movement of air, the deposits take up high surface temperature (150 to 160 deg. Fahr.) during the midday hours on bright, warm days in summer. In winter they are kept relatively cool, as the sun rarely plays upon them for more than several hours per day. On the whole, the inland initial areas are not nearly so severe as those of the sandy beaches already described.

Pioneer species very commonly found are: Mesembryanthemum edule and M. acinaforme, which form dense consocies and associes, their succulent ranks covering and binding the loose sand. These plants show no evil effects on being inundated periodically. During floods they collect much water-borne inorganic and organic matter, which appreciably assists in raising the general level of the communities, as well as improves the quality of the substratum.

Stenotaphrum glabrum develops large consocies, which take the form of rich, prostrate mats, most effective in holding the sand in place.

The opener portions of such consocies are invaded by such plants as Senecio crenatus, Stoebe capitata, Othonna amplexicaulis, Cryptostemma calendulaceum, Mariscus congestus, Helichrysum parviflorum, Chironia baccifera, Eriocephalus umbellatus, Peucedanum ferulaceum, P. capense, Sutera spp., Silene capensis, S. Burchellii, Geranium and Pelargonium spp.

Following the pioneer stages are commonly Passerina filiformis, P. falcifolia, P. vulgaris, Metalasia muricata, Erica speciosa, Simocheilus multiflorus, Phylica axillaris, Phylica spp., Psoralea pinnata, Cliffortia spp., which form consocies and associes of some extent, and prepare the way for ordinary Psammophilous macchia. Gradual improvement of soil conditions is brought about, the organic content being much increased, the substratum being converted from one of innutritious sand to a fair quality sandy loam.

The macchia may either remain subclimax, chiefly owing to absence of germules of scrub or forest species, or may, directly or through the agency of Virgilia capensis, yield play to river-bank scrub or bush. The development of forest from the scrub or bush seems to be a very slow process, owing no doubt to the general absence of those climatic factors so essential to forest progress—high humidity and reduced air temperature.

The Lithosere.

Areas: rocky portions of the coast, of the plateaux, and of the mountains.

While the area occupied to-day by the lithoseral stages is considerable, the greater portion of this carries the ultimate and penultimate stages of the succession, the pioneer stages being represented to an infinitely lesser degree. Judging from the probable, more recent geological history of the region, very extensive areas of sheet and broken rock must have been available initially for the development of the first pioneer communities of the Lithosere. Such extreme rocky areas, doubtless, in some instances, were rapidly colonized by pioneer Cyanophyceae, Lichens, and Bryophyta, which reacted in the direction of rock-decomposition and soil production. Owing to the mountain barriers immediately north of the plateaux having received little disturbance since Jurassic times, there must have been upon their summits and slopes a fair assemblage of flowering plants conveniently situated for invasion of the plateaux. Probably pioneer Phanerogams soon followed on the Cryptogams, and furthered the formation of a soil covering.

The stages of the Lithosere to-day may best be studied on the mountain slopes, along rocky river valleys, and along the rugged, rock-bound coast line.

For sake of clearness it is desirable to treat separately the succession commencing on rocky sites *inland* and that commencing on rocky sites on the *coast*.

The succession *inland* is described first.

Two distinct types of rocky surface are commonly found on the mountain summits and slopes and in rocky valleys :—

(*a*) Surfaces exposed to severe insolation, experiencing N., N.E., and N.W. or W. aspects, and wet for short periods following heavy rain only. These show absence of Cyanophyceae, and are relatively poorly clad with Lichens and Bryophytes. Soil accumulates through atmospheric weathering and gravity, or is wind-borne. Pioneer plants are either scattered Lichens and Bryophytes, or more often Xerophytic grasses and Crassulaceae.

(*b*) Surfaces exposed to moderate insolation, experiencing S., S.W., or S.E. or E. aspects, and kept moist for long periods after rain, either in virtue of their cool setting or through seepage. Such surfaces support a rich covering of Cyanophyceae in the initial stages ; later Cyanophyceae and lichens, hepatics, and mosses appear. Grasses, Crassulaceae, and macchia plants follow on the Cryptogams.

The general succession is as follows :—

1. *Cyanophyceae* (principally species of Calothrix, Schizothrix, Stigonema, Gloeocapsa).

These form a covering which is slimy during moist weather and skin-like during dry. The reaction upon the rocky surface is an effective one, resulting in the production of a fine dusty layer of disintegrated material containing a fair percentage of organic matter.

2. *Lichens* (principally species of Xanthoria, Parmelia, Lecanora, Pertusaria, Umbilicaria, Cladonia).

These mingle with the Cyanophyceae, forming extensive communities in some sites, but very open ones in others. The action of the lichen pioneers is to produce additional dusty material from the rock, and to add to this organic matter resulting from the decomposition of thalloid material cast by themselves.

3. *Bryophyta*.

The mosses and hepatics follow very soon after the lichens. The more important are Rhacomitrium incanum, Dicranum tabulare, species of Grimmia, Andreaea, Hedwigia, Polytrichum, Pogonatum, Fimbriaria ; Bryum argenteum, Bryum alpinum ; species of Brachymenium, Campylopus, Fissidens, Marchantia, Riccia, and Anthoceros.

The Bryophytes add considerably to the soil covering, not only by disintegrating further rock material, but also by collecting wind-borne matter and by returning copious amounts of organic matter to the substratum.

4 (*a*). *Drosera, Utricularia, and Various Ferns.*

On moister sites the Bryophytes are followed by Drosera capensis, D. cuneifolia, D. cistiflora, Utricularia capensis, stunted Pellaea viridis, P. quadripinnata, stunted Gleichenia polypodioides, much stunted Pteridium aquilinum ; Polypodium lanceolatum, Hymenophyllum tunbridgense, Lycopodium carolinianum, Blechnum tabulare, B. attenuatum, Asplenium cuneatum, Dryopteris Bergiana. These plants continue the work commenced by the pioneers already described—decomposition of the rock surface and accumulation of organic matter.

4 (*b*). *Xerophytic Grasses, Crassulaceae, Mesembryanthemum spp.*

On the drier sites the Bryophytes are followed by the above plants, or the plants of stage 4 (*a*) may be followed by these.

The principal grasses are Achneria capensis, Pentaschistis Thunbergii, P. angustifolia, Ehrharta brevifolia, Danthonia stricta, and Koeleria cristata*; the principal Crassulaceae are Crassula perfossa, C. platyphylla, C. rosularis, C. rubricaulis, C. turrita, C. fruticulosa, C. expansa, C. rhomboidea, C. clavifolia, C. obvallata, C. corymbulosa, Coyledon orbiculata, C. rhombifolia; Mesembryanthemum edule, M. acinaciforme, M. spp. (these require identification by a specialist†), are important plants, covering quite large areas, and reacting strongly upon the rocks. Other important plants are Senecio juncea (which thrives in the stoniest, warmest, driest sites), Aster filifolius, Gerbera piloselloides, Helichrysum paniculatum, Commelina africana, Montinia acris, Haworthia and Gasteria spp.

This stage practically covers the rocky surfaces with vegetation.

5. *Lithophilous Macchia.*

The foregoing stage [4 (*b*)] prepares the way for the macchia plants proper, by deepening the soil cover, enriching it chemically and biotically, and by improving the water conditions.

Representative plants of Lithophilous macchia are the following: Erica speciosa, E. cerinthoides, E. viridiflora, E. diaphana, E. Sparrmannii, E. transparens, E. albens, E. petraeae. E. copiosa, E. stylaris, E. imbricata, E. brevifolia, E. seriphiifolia, Blaeria fuscescens, Simocheilus multiflorus, Cliffortia octandra, C. filifolia, C. ilicifolia, Pteronia incana, P. stricta, Chrysocoma tenuifolia, Aster affinis, A. echinatus, A. erigeroides, A. filifolius, Amellus strigosus, Conyza ivaefolia, Helipterum eximium, H. gnaphalioides, Helichrysum odoratissimum, H. anomalum, H. nudifolium, H. serpyllifolium, H. appendiculatum, H. lancefolium, Stoebe microphylla, S. cinerea, Metalasia muricata, Relhania squarrosa, Athrixia capensis, A. heterophylla, Leyssera gnaphalioides, Printzia Bergii, Athanasia pubescens, A. dentata, A. pinnata, Matricaria glabrata, Senecio crenatus, S. oliganthus, S. longifolius, S. junceus (on rocks), Othonna parviflora, O. amplexicaulis, Ursinia trifida, U. anethoides, Haplocarpha lyrata, Cullumia decurrens, Gerbera spp., Heliophila spp., Muraltia stipulacea, M. filiformis, M. mixta, M. alopecuroides, Hermannia salviaefolia, H. spp., Pelargonium dipetalum, P. radulaefolium, P. caffrum, P. myrrhifolium, P. scabrum, Oxalis purpurea, O. variabilis, Diosma vulgaris, Barosma scoparia, B. ovata, Agathosma serpyllacea, A. microphylla, A. pubescens, Agathosma spp., Phylica verticillata, P. stipularis, P. lasiocarpa, P. rosmarinifolia, P. paniculata, P. axillaris, P. villosa, Phylica spp., Cyclopia subternata, Podalyria glauca, P. Burchellii, P. calyptrata, Amphithalea sp., Aspalathus ciliaris, A. Benthami, A. rigescens, A. aciphylla, A. suffruticosa, Aspalathus spp.,‡ Crotalaria purpurea, Loddigesia collinum, Psoralea pinnata, P. axillaris, Indigofera filifolia, I. coriacea, I. flabellata, Indigofera spp., Rhyncosia glandulosa, Berzelia cordata, Brunia nodiflora, Pseudobaeckea racemosa, Pharnaceum dichotomum, Lobelia hirsuta, L. pubescens, L. villosa, L. repens, L. linearis, Protea cynaroides, P. humiflora, P. grandiflora, P. longiflora, Leucadendron adscendens, L. scabrum, L. eucalyptifolium, L. plumosum, L, aemulum, L. decurrens, Leucospermum conocarpum, L. glabrum, L. attenuatum, Gladiolus spp., Antholyza aethiopica, A, caffrum, A. spp., Aristea spp., Babiana spp., Geissorhiza spp., Bobartia spp., Homeria collina, species of Ixia, Hesperanthera, Moraea, Watsonia, Caesia Thunbergii, Bulbine spp., Bulbinella spp., Eriospermum spp., Tulbaghia spp., Urginea spp., Anthericum spp., Haemanthus spp., Hypoxis spp., Vallota purpurea, Ficinia

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* Occurs in Europe; widespread.
† Specimens sent to Mrs. L. Robus.
‡ Especially *A. frankenioides* and *A. aciphylla*.

spp., Tetraria spp., Schoenoxiphium spp., Thamnochortus spp., Restio spp., Dovea spp., Hypodiscus spp., Willdenovia spp., Leptocarpus spp., Cannamois spp., Elegia spp., various Orchidaceae, and various other Monocotyledons and Dicotyledons.

While the listed plants do not occur together in one and the same spot, they are representative of the stocking of extensive areas of country that have had their origin in bare rock surfaces. The community built up is macchia, which remains climax along the mountain summits and upper slopes, and on portions of the foot-hills, or which develops into scrub, bush, or forest in congenial sites.

While the macchia originating in the Lithosere may show a number of species that occur in the macchia of the Psammosere and Hydrosere, it is clear that a certain number of the species are peculiar to it. Its structure, moreover, is different from that of Psammophilous and Hygrophilous Macchia, being of lesser height, of lesser luxuriance, and of opener nature. Lithophilous Macchia, in addition, is richer in grasses than are the other types. Either mixed with the opener, shorter macchia, or occurring in small consocies or associes in shrub-tree areas within the latter, particularly on dry northern slopes, are such grasses as Ehrharta brevifolia, E. erecta, E. capensis, E. calycina, E. Rehmanni, E. subspicata, Danthonia stricta, D. disticha, D. lanata, D. cincta, D. curva, D. papposa, D. Zeyheriana, Achneria capensis, Pentaschistis angustifolia, P. Thunbergii, P. heptamera, Koeleria cristata, Brizopyrum capense, B. brachystachyum, Lasiochloa longifolia, L. hispida, Eragrostis curvula, E. chloromelas, E. brizoides, and species of Aristida, Chloris, Harpechloa, Leersia, Lepturus, Panicum, Pennisetum, Polypogon, Trachypogon, Setaria, and Pollinia.

Themeda triandra, in areas receiving less rainfall, and particularly on northern slopes in such areas, forms fairly extensive consocies, affording excellent fodder compared with most of the other south-western and macchia grasses Toward the eastern limit of the region, scattered Andropogon nardus,* A. hirtus and H. eucomus are found, probably ruderals from the eastern grass-veld.

The development toward scrub or bush is brought about by increased luxuriance of the chief macchia species and the entry of pioneer scrub species, such as Royena pallens, Celastrus buxifolius, Rhus lucida, R. incana, R. undulata, R. longispina, R. villosa, Euclea lanceolata, Carissa arduina, Pittosporum viridiflorum, Chilianthus (oleaceus) arboreus, Rhamnus prinoides, Osteospermum moniliferum, Myrsine africana, Tarchonanthus camphoratus, Virgilia capensis, in a stunted form, may appear at this stage. Aloe spp. are sometimes associated, with the scrub forms in this transition stage.

The development on the coast is as follows :—

The succession commencing on the bare rocky crags and slides of the coast shows several features of interest. Cyanophyceae are practically entirely absent, the rocks being so exposed to wind and insolation that they are usually kept dry. Lichens† are represented by Crustaceous forms, and by a few foliose and fruticose species in more sheltered sites. Mosses and hepatics, too, are practically wanting. The Crustaceous lichens paint the rocks red, yellow, green, grey, and brown, but appear to disintegrate the surfaces at a very slow rate.

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* Occurs in scrub at De Vlugt.
† Most of these are undescribed as yet.

The most efficient pioneers are succulents and scrub plants. Three distinct types of pioneer community are to be distinguished, and these are described below :—

1 (*a*). *Crassulaceae, Mesembryanthemum spp., Chironia, and other spp.*

Crassulaceae (chiefly C. perfossa, C. rhomboidea, C. rubricaulis, C. rosularis, C. platyphylla, C. fruticulosa, and Cotyledon orbiculata), Mesembryanthemum edule, M. knysnanum, M. acinaciforme, M. tenellum, M. spp., Tetragonia fruticosa, Gazania uniflora, Senecio junceus, Helichrysum paniculatum, H. parviflorum, H. crenatus, Eriocephalus umbellatus, H. capitellatus, E. racemosus, Chironia baccifera, Solanum quadrangulare, Statice scabra, Passerina rigida, Aristea capitata, Haemanthus albiflos, Asparagus africanus, Freesia refracta, Antholyza aethiopica, Agapanthus umbellatus, Stenotaphrum glabrum, and Sporobolus pungens, are the more important species of this particular pioneer stage. The plants find root-hold in the crevices in the rocks, and gradually add to the soil covering through disintegration of the rock, collection of aeolian-borne matter, and return of organic matter. The species are usually found in small *families* (groups of individuals belonging to the same species) and *colonies* (initial communities of two or more species), which ultimately produce consocies and associes of some extent. Much open rocky surface appears between the various small communities of this stage.

An alternative pioneer community is 1 (*b*) below.

1 (*b*). *Aloe arborescens and Scrub Pioneers.*

The seedlings of the succulent Aloe arborescens find root-hold in the crevices in the rocks, and within a few years so enlarge these crevices, and so collect sandy material, that they form less precarious growing centres for themselves. Development of the aloe seedlings continues for a number of years, until the plants attain heights ranging from 6 to 18 feet ; they are always much branched, and form an appreciable canopy when at all close together. Under cover of the aloes appear scrub pioneers, which find root-hold in various cracks, crevices, and local sandy spots. The more important species appearing at this stage are Capparis citrifolia, C. Guenzii, Niebuhria pedunculosa, Euclea racemosa, E. lanceolata, Royena pallens, Celastrus buxifolius, C. nemorosus, Celastrus acuminatus, C. peduncularis, Hartogia capensis, Cussonia thyrsiflora, Sideroxylon inerme, Tarchonanthus camphoratus, Chilianthus arboreus, Myrsine africana, and Carissa arduina ; minor plants are Chironia baccifera, Crassula perfossa, C. rubricaulis, C. rosularis, Cotyledon orbiculata, Agapanthus umbellatus, Haemanthus puniceus, H. albiflos, Hypoestes aristata, Polygala ericaefolia, and Stachys aethiopica. The communities extend in area, and are later joined by additional scrub forms, ultimately developing into typical littoral scrub. In the latter community, Aloe arborescens is gradually killed out, owing to the dense shade cast.

An alternative pioneer community is 1 (*c*) below.

1 (*c*). *Celastrus procumbens—Other Scrub Pioneers.*

Occasionally Celastrus procumbens, Rhus crenata, Capparis citrifolia, C. Guenzii, Cussonia thyrsiflora, Grewia occidentalis, Carissa arduina, Acokanthera venenata, Euclea racemosa, E. lanceolata, E. macrophylla, Sideroxylon inerme, and several other scrub species are the first colonizers of bare rocky surfaces. These hardy and adaptable forms find slender root-hold in various cracks and crevices, and form stunted, prostrate, but exceedingly rigid and dense mats of woody, sclerophyllous vegetation that in parts completely cover the rocks. Rocks within the reach of the spray of the ocean, and receiving the severest of insolation, and subject to relatively long drought periods, often bear communities of gnarled, malformed shrubs of the species listed, the height ranging from 6 to 18 inches. By very slow but very steady improvement of edaphic conditions, and the extension of some shelter to the regeneration of incoming species, these grotesque communities may develop into ones that are taller and more luxuriant. In very extreme sites it seems that they must remain in a subclimax state for very lengthy periods. The general procedure, however, is for littoral scrub and littoral bush to develop from these pioneer scrub communities.

2. *Mixed Macchia and Scrub Forms.*

As shown in the schematic chart, the pioneer stages (1*a*, 1*b*, 1*c*) already described develop into littoral scrub. Before this community is built up, however, there appears an intermediate one, composed of mixed macchia and scrub forms. Stage 1 (*a*) always develops to this particular community before building up littoral scrub, but in the stages 1 (*b*) and 1 (*c*) this community may be omitted.

The principal plants of this mixed community are as follows: Erica speciosa, E. formosa, Phylica lasiocarpa, Barosma scoparia, Metalasia muricata, Osteospermum moniliferum, O. corymbosum, Restio eleocharis, Rhus crenata, Rhus lucida, Royena pallens, Euclea spp., Carissa arduina, Capparis spp., Celastrus procumbens, C. buxifolius, C. nemorosus, Solanum rigescens, Pavonia mollis, Zygophyllum morgsana, Z. fulvum, Z. flexuosum, Peucedanum capense, Heteromorpha arborescens, Grewia occidentalis, Sideroxylon inerme, Allophyllus decipiens, A. erosus, Olea capensis (very much stunted), Olea exasperata (a diminutive Olea), the scandent Cussonia thyrsiflora, and the lianes Rhoicissus, R. digitata, Cissus cuneifolia, Scutia (indica) Commersonii, which are often prostrate or semi-prostrate. Passerina rigida, small P. falcifolia, Stoebe cinerea, Podalyria spp., Crotalria spp., are found on some sites. Pelargonium spp. are usually present.

The listed plants usually occur in mixed associes, although quite extensive consocies of Erica speciosa, Phylica lasiocarpa, Metalasia, Rhus crenata, and the prostrate lianoid Cussonia and Rhoicissus capensis are to be found.

The species produce regeneration very slowly, except in the instances of Osteospermum, Metalasia, and Rhus crenata, and must take very lengthy periods to complete the covering of the crags and slides of rock.

This stage sees the general incoming of scrub and bush species, which in time convert the open, mixed macchia-scrub community into littoral scrub proper, an exceedingly dense—almost impenetrable—shrub-stunted tree community described in Chapter V.

The various stages of the four main seres and of their several locality types are shown in the Schematic Chart. This chart, in addition, shows such relationships as exist between certain communities of the several seres.

The general successional tendencies shown by vegetation in the region are summarized in Chapter VIII, Part (*a*).

Scrub and scrub species and bush are described in Chapter V, while forest is treated in Chapters VI, VII, IX, and X.

Aspect Alternes.

Before concluding this chapter, a brief description of *alternation* in *medial successional stages*, produced by aspect, is essential. The influence of exposition on *forest* proper is referred to on pages 25, 40, (also Table VII), 53, 187–188, 195–199, and therefore requires no description here.

The northern, north-western, north-eastern, and western aspects usually constitute *Xeroclines*, or the dry, warm slopes, while the southern, south-western, south-eastern, and eastern form the *Mesoclines*, or moist, cool slopes.

The sides of valleys and of hills afford striking examples of the *alternation* brought about by aspect, acting through the prime ecial factors, light-intensity, air and soil temperatures, and moisture-content of the soil. The xeroclines receive stronger light for longer periods than do the mesoclines, while the mean temperatures of air and of soil are higher by 5–10 degrees Fahr., according to vegetation covering, colour and texture of soil, and angle of slope. The mean moisture-content of mesoclines is higher by 5–50 per cent. (on dry weight), according to vegetation covering, nature and depth of soil, and angle of slope.

It is necessary to point out that, in a number of instances, *seeming* aspect alternes are *really* alternes produced by differences either in geological formation (e.g., Bokkeveld and T.M.S. outcrops on opposite sides of valleys and hills), or in soil depth ; naturally, such are not to be confused with aspect alternes.

The following examples of aspect alternes in medial stages suffice to indicate the important *role* of exposition :—

(1) The *Xerocline* of a valley or hill shows *stunted macchia* 2–3 *feet high*, while the *mesocline*, often not more than 50 yards distant, shows *luxuriant macchia to* 15 *feet in height*.

(2) The *xerocline* of a valley or hill shows *tall macchia to* 15 *feet in height* ; the *mesocline*, *bush* or *bush transitional to forest*.

(3) The *xerocline* shows *scrub of stunted nature*, the *mesocline*, *luxuriant scrub* and *bush transitional to forest*.

(4) Further inland, toward the north and north-east of the region, the *xerocline* shows *mixed scrub and grass* (e.g., Themeda triandra), the *mesocline tall macchia*. For this reason, the *xerocline* affords better pasture than the *mesocline*.

The lines of division between the communities of opposing slopes of valleys or of the opposite slopes of hills, are usually sharp, but in some instances transitional communities link the populations of the different aspects.

From a study of the prime habitat factors of aspect alternes and of their vegetation, it seems clear that a climatic swing in the direction of increased humidity would result in the advancement of the vegetation of the mesoclines, whereas a swing toward aridity would accelerate the development of that of the xeroclines.

Chapter V.

SCRUB AND BUSH.

Chapter V.

SCRUB AND BUSH.

(*a*) Scrub.

Scrub develops from macchia on the coast and inland alike, and, as pointed out in the description of the coastal Lithosere, Chapter IV, it may arise from pioneer scrub communities that are at first of relatively open nature.

Two scrub types are to be distinguished, these being habitat modifications of the same community. The type may best be defined as *Littoral Scrub* and *Inland Scrub*. As the names imply, the former occurs within short distances of the sea, the latter on the plateaux and foot-hills of the interior. Such differences as exist between these types are entirely structural; the flora is common to both.

Littoral scrub, whether it originates in the Lithosere or the Psammosere, or develops from local hydroseral communities fringing the river estuaries, is always more stunted, more gnarled, more slow-growing than scrub holding ground away from the severe atmospheric and edaphic conditions of the sea shore. One of the most important factors responsible for the moulding of the physiognomy of *littoral scrub* is the landward wind prevailing during the warmer hours of practically every day in the year. The wind shears down, as it were, the crowns of the scrub dominants, so that the general canopy from a distance assumes the aspect of an inclined plane, the lowest portion of which occurs nearest to the sea. In addition, branch development in the direction from which the prevailing wind is blowing is inhibited, with the result that abnormally active development takes place in the opposite direction. Growth in the short stems, too, is practically entirely in the direction away from the prevailing wind—grotesque, flattened, or ribbon-like growths often being produced in this way.

The foliage is usually more succulent and the leaves smaller in *littoral scrub* than in *inland*, species for species. On the whole, the littoral type is denser and possesses a closer, less interrupted canopy than the inland type.

Littoral and *inland scrub* ranges in height from several feet (at the edges of the coastal cliffs, and on the hottest, driest, shallowest-soiled sites inland) to 15 feet. The species of which scrub is composed, no matter whether they are capable of growing to large dimensions under congenial conditions or not, remain stunted owing to the adverse conditions climatically and edaphically. The community has to react not only upon the edaphic conditions ere better growth is produced in species capable of showing it, but has also to produce suitable atmospheric conditions. Through a gradual process of canopy improvement, through gradual increase in height of that canopy (i.e., building up of bush on ground that previously bore short scrub), the humidity of the air is increased, the temperature of the air is sufficiently reduced, and the rate of evaporation brought down appreciably.

The most important features respecting scrub are as follows:—

(*a*) The large number of subtropical species that occurs within it.

(*b*) The abundance of true woody shrubs and stunted trees; the development of spines; the increase in numbers and in individuals of lianes as compared with macchia; the occasional occurrence of succulents: species of Cotyledon and Crassula, Haworthia, Stapelia, Aloe.

(*c*) The impenetrable, densely-massed nature of the vegetation.

(*d*) The rarity of regeneration of typical scrub shrubs, but the gradual increase in number, in high scrub, of seedlings of forest trees of pioneer nature.

(*e*) The general absence of dominance, except over exceedingly small areas. Dominance is not a marked feature in high forest at the Knysna, but in scrub it is even a rarer one. There is a general mixing of shrub and stunted tree forms.

(*f*) Important canopy-forming species are as follows: Royena pallens, Euclea lanceolata, E. racemosa, Pterocelastrus variabilis (much stunted); Scolopia Zeyheri (heavily armed and much stunted); Apodytes dimidiata (in the form of a grotesque-shaped, gnarled shrub); Celastrus buxifolius (with a wealth of formidable spines and few leaves); Celastrus acuminatus (with reduced foliage and heavy arms); Rhus lucida (sometimes in consocies); R. incana; R. mucronata; R. longispina; Pittosporum viridiflorum (abundant locally in dry river valleys inland); Olea verrucosa (on dry sites inland); Carissa arduina; Scutia indica (shrub form); Osyris abyssinica; Plectronia ventosa (which forms armed consocies); Myrsine melanophleos (much reduced in size); M. africana; Grewia occidentalis (shrubby or lianoid); Capparis citrifolia (liane); Dodonaea Thunbergiana (local, near streams, in small consocies); Ekebergia capensis (much gnarled and stunted); Heteromorpha arborescens; Myrica conifera; Tarchonanthus camphoratus (stunted, malformed, in consocies in places); Chilianthus arboreus (much stunted); Buddleia salviaefolia. In opener sites between the shrubs appear Elytropappus rhinocerotis, Stoebe spp., Passerina filiformis, P. vulgaris (local); Erica speciosa, E. canaliculata, Tetragonia spp, Mesembryanthemum spp, and xerophytic grasses. Under the shrubs are societies of Hypoestes spp., Barleria pungens, Blepharis spp., Justicia Bowiei; Rhinacanthus sp., and Knowltonia spp., along with scattered Haemanthus spp., Moraea iridioides and Pellaea spp. Aloe arborescens is an important plant on the littoral, and occasionally occurs inland as well. Podocarpus elongata L'Herit., much gnarled and stunted, is to be found near water courses; P. Thunbergii Hook is much rarer.

The general physiognomy of scrub at the Knysna is much the same as that of the eastern Cape Province and of portions of Natal, except that the grotesque-shaped, candelabra tree—euphorbias (E. grandidens, E. triangularis, E. tetragona, etc.) are absent, as are the masses of succulent Portulacaria afra, Crassula portulaca, and introduced Opuntia spp. Conspicuous through their absence, too, are the following typical scrub forms of the eastern side: Zizyphus mucronata, Ehretia hottentotica, Randia rudis, Acacia karroo, A. caffra, Schotia speciosa (rare at Knysna), Pappea capensis (eastern portions of Knysna area), Plectronia ciliata, Rhus mucronifolia, Tecomaria capensis, Plumbago capensis (rare at Knysna), Albuca Hookeriana and Sansevieria thyrsiflora. Aloe spp. are few, while the number of individuals present is small contrasted with the eastern scrub.

The absence of an abundance of grasses between the shrubby masses and along the scrub margins, and the presence of macchia plants in these positions, readily distinguish Knysna from eastern scrub.

Scrub forms occurring within the region, together with such stunted forest species that find a home in the community, are listed on pages 150–160.

(*b*) Bush.

Scrub usually develops in height, attains greater luxuriance, is invaded by typical forest species, and builds up bush. On the other hand, the Psammophilous macchia of the inland type may give rise to bush directly; the same is true of Hygrophilous macchia.

Bush differs from scrub primarily in its physiognomy—it assumes the aspect of what might be considered either *very luxuriant scrub* or *short, poorly-developed forest*. In a word, bush is the transition stage between scrub and forest. As would be expected of such a transition community, bush shows the presence of more and more forest species proper as its development proceeds. It shows the presence of Podocarpus elongata L'Herit. and of P. Thunbergii Hook. in fair numbers, while other important species appearing are Apodytes dimidiata (tree form, with thick, dark bark); Ocotea bullata; Ilex; Gonioma Kamassi; Curtisia faginea, Scolopia Mundtii; S. Zeyheri (both in tree form); Olea laurifolia (a small tree); small trees of Myrsine melanophleos, Ekebergia capensis, Kiggelaria africana, Calodendron capense, Toddalia* lanceolata, Celtis rhamnifolia, Fagara Davyi, Rhus laevigata, Ficus capensis, Elaeodendron Kraussianum, E. croceum, E. capense, Mystroxylon spaerophyllum, Celastrus acuminatus, C. peduncularis, and Royena lucida occur.

The general height of the canopy ranges from twenty to thirty feet, the result being that a forest atmosphere—high humidity, low temperature, low light-intensity, low rate of evaporation—is produced. The edaphic factors—depth of soil, degree of soil moisture, humus content, total available soluble salts—are appreciably improved.

There is a general increase in numbers of species and of individuals of ferns, fungi, lianes, and epiphytes.

As in the instance of scrub, there are two well-defined types, the products of habitat influences: the littoral bush of the sea cliffs and the inland bush of the plateaux and foothills of the interior. The differences between the types are almost entirely structural, for the great majority of the species of the littoral type are found in the inland. The latter type is usually better grown, less gnarled, of greater rate of growth, and of greater luxuriance than the littoral type, principally owing to the fact that the littoral type is produced on drier soils and receives less actual rainfall.

Where either type mingles with the marginal members of forest proper, there are some really well-shaped, tall (thirty-five to forty feet high) trees of the best species, particularly of Sideroxylon, Apodytes, Pterocelastrus, Ekebergia, and Myrsine. Along the coast there is often a striking zonation as the sea is left: pioneer stages of the Lithosere, littoral scrub, littoral bush, littoral forest of shorter height than normal climax forest inland. Inland the zonation is usually less marked, owing to various complicating factors, chiefly differences in aspect, soil moisture, and soil depth, and to agents of disturbance.

As the species of the bush community are a mixture of scrub and of forest species, a special list of these is not necessary.

As exemplifying the extremely slow rate of growth in littoral bush, the data given in *Table XXXII* (p. 138) are interesting.

From bush of both types forest develops: on the coast the shorter, less luxuriant, drier type†; inland the taller, better-class types.

Bush developing in the hydrosere is usually capable of developing into a moister type of forest than bush developing either in the psammosere or in the lithosere.

On extreme sites—for example, on rocky, exposed sites on the coast, or on shallow-soiled, warm slopes inland—bush may remain as a subclimax for lengthy periods, probably several centuries.

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* Vepris lanceolata G. Don.
† *Vide* "Forest Types," Chapter VII.

Table XXXII.

ANNUAL GIRTH INCREMENT SHOWN BY THE 14 SPECIES OF TREES IN LITTORAL BUSH (10–200 FT. ELEVATION, NOETZIE BEACH.

Girth Classes.	Number of Trees Studied.	Species.	Period of Observation.	Girth Increment.
Inches.				Inches.
7–12........	9	Podocarpus. Thunbergii. Hook....	1925–26	·0902
13–18........	5	—	—	·2125
19–24........	2	—	—	·0937
7–12........	1	Podocarpus elongata. L'Herit.....	1925–26	·1875
13–18........	1	—	—	·0625
19–24........	4	—	—	·2812
31–36........	1	—	—	·3750
37–42........	1	—	—	·2500
43–48........	1	—	—	·2500
7–12........	1	Apodytes dimidiata...............	1925–26	Nil.
19–24........	1	—	—	·3750
0– 6........	1	Gonioma. Kamassi...............	1925–26	·1875
7–12........	1	—	—	Nil.
0– 6........	2	Pterocelastrus variabilis...........	1925–26	·1875
7–12........	2	—	—	·1875
25–30........	1	—	—	·0625
31–36........	1	—	—	·1875
7–12........	1	Elaeodendron croceum............	1925–26	·0625
13–18........	1	—	—	·2500
0– 6........	2	Elaeodendron kraussianum.........	1925–26	·1250
7–12........	7	—	—	·3572
19–24........	1	—	—	·1875
0– 6........	2	Myrsine melanophleos.............	1925–26	·1562
19–24........	1	—	—	·3125
13–18........	1	Plectronia obovata..............	1925–26	·3125
7–12........	2	Ochna arborea...................	1925–26	·0312
19–24........	2	—	—	·0312
7–12........	2	Royena pallens..................	1925–26	·2500
19–24........	1	—	—	·3125
7–12........	2	Euclea macrophylla..............	1925–26	·1250
0– 6........	1	Olea foveolata....................	1925–26	·1875
7–12........	5	—	—	·1375
7–12........	2	Scolopia. Zeyheri.................	1925–26	·3125

The more important species found in scrub are given below. Many of these occur in bush as well, but in that community are associated with various forest species. For sake of easy reference, the Dicotyledonous families are listed alphabetically.

PHANEROGAMS.

1. *Gymnosperms.*

The Taxaceae contain stunted individuals of the giant "Outeniqua," Podocarpus elongata L'Herit. (P. falcatus R.Br.) and of the "Upright Yellow-wood," P. Thunbergii Hook. (P. latifolius R.Br.).

P. elongata, showing a clear bole of about six feet in height and of about twelve feet in girth at breast height, are commonly found in littoral scrub. The crowns of such individuals are of considerable extent, but are developed in the direction of the prevailing sea wind. The boles, too, are seldom cylindrical, but are flattened on the sides exposed to sea winds.

The two species of Podocarpus fruit profusely in *littoral* scrub, but most of the fruits are non-viable, and few that are sound ever germinate. Regeneration of the species is very rare, and is very slow-growing.

The Podocarpus spp. do not occur in *inland* scrub, except along river and stream banks.

The small Widdringtonia cupressoides (Pinaceae) is to be found in both *littoral* and *inland* scrub, but sparingly, it being a plant favouring open macchia.

2. *Angiosperms.*

(i) *Monocotyledons.*

The more important Monocotyledons of the scrub are: Brunsvigia gigantea (*littoral*), Haemanthus albiflos, H. callosus, H. puniceus, Zantedeschia aethiopica, Cyanotis nodiflora, Wahlendorfia thyrsiflora, Ficina and Tetraria spp. (of drier soils), Mariscus congestus, Carex aethiopica, Stenotaphrum glabrum (open sites), Moraea iridioides, Aristea pusilla, Antholyza caffra, Aloe arborescens (chiefly *littoral*), A. saponaria, A. latifolia, A. lineata, A. pluridens, A. striata—chiefly *inland;* Agapanthus umbellatus, Asparagus africanus, A. crispus, A. Thunbergianus, A. sarmentosus, A. medeoloides, Eriospermum spp., Gasteria spp., Haworthia spp. (more karroid areas inland), Kniphofia spp., Ornithogalum spp., various orchids and several Restiaceae.

(ii) *Dicotyledons.*

Acanthaceae.

Barleria pungens, Blepharis capensis, B. molluginifolia, Chaetacanthus Personii, Hypoestes aristata (chiefly *littoral*), H. verticillata, Isoglossa sylvatica, Justicia Bowiei, Rhinacanthus sp. nov. (*littoral*), Thunbergia capensis—under shrubs, herbs, erect or decumbent, often in small socies favouring the moister, more shaded portions in scrub.

Aizoaceae.

Galenia africana, woody shrub two to three feet high, common in dry, open scrub; Mesembryanthemum spp., chiefly M. edule, M. acinaciforme, M. tenellum, and about forty-eight other species, prostrate and fruticose, occur, principally on exposed sites in dry, inland scrub. Pharnaceum dichotomum, P. distichum, Tetragonia fruticosa, T. decumbens, are found on dry sites.

Anacardiaceae.

Rhus crenata, R. dentata, R. excisa, R. incana, R. laevigata (a stunted tree), R. longispina, R. stenophylla, R. tomentosa, R. undulata, R. pubreula, var. fastigiata, R. Thunbergii, R. lucida, R. obovata—woody shrubs to fifteen feet in height, much gnarled. Laurophyllus capensis (Botryceras laurinum) is to be found in inland scrub of moister nature.

The species of Rhus are most important plants of the scrub, providing dominants and subdominants for numerous small consocies and small associes. They fruit profusely, but do not provide much regeneration.

Apocynaceae.

Acokanthera venenata : a woody shrub, often in consocies ; its flowers are showy in the mass, are sweet-scented, but decidedly poisonous. A. venenata var. spectabilis is recorded, but has not been seen. Carissa arduina, C. haematocarpa* : rigidly-armed shrubs.

Asclepiadaceae.

Asclepias crispa, A. expansa, A. fruticosa, Astephanus marginatus, A. neglectus, Cynanchum africanum, C. capense, C. obtusifolium, Pachycarpus dealbatus, P. grandiflorus, Riocreuxia torulosa, Sarcostemma viminale, Schizoglossum cordifolium, S. heterophyllum, S. linifolium, S. tomentosum, S. aschersonianum, Secamone Alpini, Tylophora sp., Xysmalobium involucratum, X. undulatum : sub-shrubs, herbs, and climbers, never very abundant in any one site, but fairly well distributed. Stapelia variegata and S. verrucosa occur on stony, exposed, semi-karroid sites.

Araliaceae.

Cussonia thyrsiflora (woody scrambler), C. spicata (tree), toward the eastern limit.

Bixaceae.

Dovyalis (Doryalis) longispina (coastal, and toward east), D. rhamnoides : thorny shrubs, the latter species forming near the sea dense associes with other scrub shrubs ; Kiggelaria africana, a variable and stunted tree ; Scolopia Zeyheri : thorny, stunted tree ; Trimeria alnifolia, shrub or small tree.

Campanulaceae.

Lobelia spartioides (inland), L. hirsuta, L. tomentosa, L. erinus, Cyphia sylvatica, Wahlenbergia capillaceae, W. procumbens, Lightfootia ciliata, L. umdentata : weak herbs.

Capparidaceae.

Boscia caffra : shrub, abundant on coasts ; Capparis citrifolia, C. Guenzii : armed scramblers ; Niebuhria pedunculosa, shrub. These plants are important members of the scrub, the Capparis spp. often forming impenetrable, thorny tangles.

Caryophyllaceae.

Silene bellidioides, S. capensis, S. Burchellii, Cerastium capense, herbs found in opener sites, especially in littoral scrub.

Celastraceae.

This is an important scrub family, providing dominants and subdominants for most of the scrub communities ; most of the forms exhibit considerable variation. The fruit crops are poor, except in the instance of Celastrus buxifolias (Gymnosporia buxifolia).

Cassine scandens, C. scandens var. latifolia : scandent shrubs ; Celastrus acuminatus (unarmed), C. peduncularis (stunted tree), C. (Gymnosporia) polyacanthus (inland), C. procumbens (prostrate, littoral), C. cordatus (coastal), C. nemorosus (armed), C. buxifolius (armed and very variable) ; Elaeodendron croceum, E. capense, E. Kraussianum : stunted trees ; Mystroxylon confertiflorum, M. sphaerophyllum, M. eucleaeforme, M. laurinum, M. apiculatum :

* To the east, and inland, only.

stunted trees or large shrubs; Pterocelastrus variabilis, a stunted tree, Putterlickia pyracantha (armed scandent shrub); Hartogia capensis (shrub, frequent inland).

Compositae.

Artemisia afra, sub-shrub; Brachylaena neriifolia, large shrub, along watercourses; Elytropappus rhinocerotis: small shrub, very abundant on drier sites, an invader from the Karroo* Eriocephalus capitellatus: small shrub, very abundant near coast; Gerbera spp. (4); Metalasia muricata, sclerophyllous shrub; Mikania capensis, climber; Osteospermum moniliferum, O. corymbosum, O. coriaceum, O. imbricatum: shrubs of straggly nature; Stoebe cinerea, shrub; Tarchonanthus camphoratus, gnarled, stunted tree; Senecio mikanioides, S. quinquelobus, S. angulatus, S. deltoideus, S. macroglossa: climbers.

Convolvulaceae.

Cuscuta africana, C. appendiculata, C. cassytoides: parasites on various scrub plants.

Crassulaceae.

Cotyledon orbiculata, C. rhombifolia, C. ramosissima, Crassula lactea, C. fruticulosa, C. Harveyi, C. crenulata, C. rubricaulis, C. perfossa, C. tumita, C. rhomboidea, C. corymbulosa, C. rosularis, C. ericoides, C. sphaeritis, C. clavifolia, C. ciliata, C. crenulata, C. denticulata, C. obvallata, and others: succulent undershrubs on stony, exposed sites.

Cruciferae.

Heliophila spp. (about five): weak shrubs.

Cucurbitaceae.

Melothria punctata, M. hederacea, Kedrostis nana: climbers.

Ebenaceae.

Euclea acutifolia, E. daphnoides, E. lanceolata, E. macrophylla, E. multiflora, E. polyandra, E. racemosa: woody shrubs of varying size, entering abundantly into all scrub associes. Royena glabra, R. cordata, R. hirsuta, R. lucida, R. pallens, are important shrubs or stunted trees.

Ericaceae.

Ericaceae are found sparingly in scrub, the only species of importance being Erica speciosa, E. canaliculata, E. caffra, which form small communities on opener areas in moister localities.

Euphorbiaceae.

Cluytia affinis, C. daphnoides, C. pulchella, C. alaternoides, C. ericoides, C. laxa, C. polifolia, C. pubescens, C. rubricaulis, Acalypha decumbens, A. glabrata, A. Ecklonii, Adenocline mercurialis, A. sessiliflora, A. humilis, A. serrata, Andrachne ovalis, Leidesia capensis: shrubs or herbs; Ctenomeria cordata, a twiner; Euphorbia elliptica, E. epicyparissias, E. ericoides, and the exotic E. helioscopia and E. peplus are small herbs; Lachnostylis is a large shrub or small tree.

Cluytia pulchella, Acalypha glabrata, Lachnostylis capensis, are important species entering many coastal and inland scrub communities. Inland Cluytia spp., Adenocline spp., Acalypha spp., Leidesia, and Ctenomeria occur, while the Euphorbia spp. found on the coast are also present, together with E. clava, E. genistoides, E. Kraussiana, E. mauritanica, and E. pubiglans. Succulent tree-euphorbias are found near the eastern limit of the region, in the district of Humansdorp, and then only here and there; these are E. grandidens, E. triangularis, E. tetragona.

* This plant requires observation as it is tending to increase in drier, fired sites.

Gentianaceae.

Chironia baccifera is the most widely spread Gentianaceous plant in scrub : it is a perennial with reduced leaves and divaricating branches, forming dense " clumps " ; while C. jasminoides, C. peduncularis, C. melampyrifolia occasionally occur in coastal scrub, they are more truly forest species ; C. tetragona favours the coastal scrub, as does Orphium frutescens. These plants are either biennial or perennial, lax herbs, with the exception of Orphium frutescens, which is a small perennial shrub. Sebaea spp. belong more naturally to moist areas and to forest, but sometimes S. elongata, S. annea, S. crassulaefolia are to be found ; these are small, weak annuals or biennials.

Geraniaceae.

Geranium canescens, G. incanum, G. ornithopodum, Monsonia ovata, Pelargonium longifolium, P. dipetalum, P. lobatum, P. myrrhifolium, P. candicans, P. urbanum, P. iocastrum, P. peltatum, P. alchemilloides, P. laevigatum, P. divaricatum, P. zonale, P. reniforme, P. scabrum, P. capitatum, P. radula, and others : small herbs and undershrubs, some of them semi-succulent.

Icacinaceae.

Apodytes dimidiata : tree much stunted and malformed ; Cassinopsis capensis : large, straggly, armed shrub, forming impenetrable thickets. Pyrenacantha scandens is a scrambler or liane.

Labiate.

Ballota africana, Leonotus leonurus, Plectranthus fruticosus (damper portions only), P. laxiflorus, P. Thunbergii, Salvia aurea (littoral), S. aurita, Stachys aethiopica, S. serrulata, S. Thunbergii, Teucrium africanum, T. capense : herbs and herbaceous shrubs, seldom abundant.

Leguminosae.

Acacia Karroo* occurs as a rare plant in portions of Uniondale Division, and is frequent in the lower portion of the Humansdorp Division. Borbonia lanceolata, Cassia tomentosa, and C. occidentalis are locally abundant ; Psoralea pinnata, P. spp. ; Sutherlandia frutescens ; Virgilia capensis is a stunted tree in moister scrub near forest ; species of Aspalathus, Argyrolobium, Crotalaria, Indigofera, Lessertia, Podalyria, Priestleya, Rhynchosia occur, but belong more truly to macchia ; Schotia latifolia is found in coastal and inland scrub as a stunted shrub ; S. speciosa is rarer, both species increasing in numbers and luxuriance as the east is approached.

Loganiaceae.

Buddleia salviaefolia, Chilianthus arboreus, C. dysophyllus (east), are large shrubs or stunted trees of some importance in littoral scrub communities.

Loranthaceae.

Parasites on various woody shrubs and trees : Viscum capense, V. rotundifolium, V. obscurum, Where abundant, Viscum spp. do much harm to their hosts, ultimately killing them.

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* A few plants introduced by oxen, sheep or goats from the Uniondale Division occur within the Knysna Division, at Diep River and Karatara.

Malvaceae.

Abutilon indicum, A. Sonneratium; Hibiscus aethiopicus, H. diversifolius, H. gossypinus, H. Ludwigii, H. pedunculatus, H. trionum, H. pusillus; Malvastrum calycinum, M. capense, M. tridactylites, M. divaricatum, M. grossulariaefolium, M. virgatum; Pavonia mollis, P. praemorsa; Sida triloba: soft-leafed fibrous shrubs favouring well-lighted areas in littoral and inland scrub.

Meliaceae.

Ekebergia capensis: stunted tree, variable, frequent in littoral scrub.

Menispermaceae.

Antizoma capensis, Cissampelos capensis: weak shrubs or climbers; C. torulosa, vine-like climber.

Moraceae.

Ficus capensis, a stunted tree or shrub, *cauliflorous;* F. Burtt-Davyi. prostrate or semi-erect shrub; both species may be either *epiphytic* or *parasitic*.

Myricaceae.

Myrica cordifolia is entirely coastal; M. Burmanni, usually coastal; M. quercifolia, M. conifera, either coastal or inland: small woody shrubs of importance in pioneer littoral scrub as sand fixers.

Myrsinaceae.

Myrsina africana, woody shrub; M. melanophleos: a stunted tree, of considerable importance in littoral scrub.

Ochnaceae.

Ochna arborea, stunted tree; O. atropurpurea, coastal shrub.

Oleaceae.

Jasminum tortuosum *(eastern limits), a climber; Olea capensis, large shrub; O. exasperata, small shrub (coastal); O. foveolata, large shrub; O. verrucosa (inland only), small tree. The Olea spp., except O. verrucosa, are of importance in scrub at the coast; O. verrucosa is a feature of inland scrub occurring on exposed, rocky " kopjes " and mountain sides.

Oxalidaceae.

The only important spp. in coastal and inland scrub are Oxalis purpurea, O. obtusa, O. punctata, and O. polyphylla.

Papaveraceae.

Papaver aculeatum†: annual herb on damper sites.

Piperaceae.

Peperomia reflexa, epiphytic on boles of stunted trees or shrubs in cooler, moister sites; Piper capense, a weak shrub, locally frequent.

Pittosporaceae.

Pittosporum viridiflorum, small tree or shrub, occasional in littoral scrub, more abundant in inland; fruits profusely.

Plumbaginaceae.

Plumbago capensis, a scandent shrub, local, coastal (e.g., at Plettenberg Bay, Keurbooms River, Buffalo Bay); possibly introduced from Humansdorp Division, but becoming naturalized.

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* *J. angulare* has been introduced at Wittedrift, in scrub.
† Exotic.

Polygalaceae.

Mundtia spinosa, an armed shrub, chiefly coastal ; Polygala myrtifolia, a weak, woody shrub ; P. oppositifolia, P. pinifolia, P. virgata : small shrubs.

Primulaceae.

Samolus Valerandii, S. porosus : fasciated herbs frequent at margins of coastal scrub.

Proteaceae.

These are more truly members of macchia, but several species linger in open scrub. Leucadendron salignum (large shrub), L. eucalyptifolium (large shrub), L. aurantiacum (small shrub), L. adscendens (small shrub), L. strictum (weak, small shrub), L. Phillipsii (medium-sized shrub, inland) ; Leucospermum conocarpum, Protea Mundtii, P. cynaroides, P. lacticolor, P. neriifolia : fairly large shrubs.

Ranunculaceae.

Clematis brachiata*, a woody liane ; Knowltonia daucifolia, K. glabricarpellata, K. rigida, K. vasicatoria, K. brevistylis : perennial herbs with rigid, ternate leaves, particularly abundant in littoral scrub, where they form dense ground socies.

Rhamnaceae.

Phylica spp. are macchia plants,but on occasion relicts are found in scrub : P. lasiocarpa, P. paniculata, P. verticillata, P. axillaris. Noltea africana, a shrub ten to fifteen feet high, is found near water, inland and to the east. Rhamnus prinoides, a bushy shrub with dense foliage, forms consocies ; Scutia Commersonii (S. indica) is an armed scandent.

Rosaceae.

Cliffortia spp. are really macchia plants, but occasionally Cliffortia falcata, C. filifolia, C. juniperina, C. linearifolia, C. iliciflora, C. octandra, occur in open areas in scrub, as do Rubus pinnatus, R. rigidus, and the naturalized exotic R. fruticosus.

Rubiaceae.

Burchellia capensis, large woody shrub ; Galium glabrum, G. asperum : weak, flexuous herbs ; Galopina circaeoides, procumbent herb ; Plectronia Mundtii, P. obovata : stunted trees ; P. ventosa, P. spinosa : armed woody shrubs ; all the species of Plectronia are important constituents of littoral and inland scrub ; Rubia petiolaris is an erect coastal scrub herb.

Rutaceae.

Calodendron capense, stunted tree, deciduous ; Clausena inaqualis, small woody shrub ; Vespris (Toddalia) lanceolata, stunted tree ; Fagara capense, small stunted shrub ; F. Davyi, stunted tree ; Barosma scoparia occurs in littoral scrub ; Empleurum serrulatum, a tall shrub, favours scrub along watercourses.

Salvadoraceae.

Azima tetracantha, armed shrub, rare along coast, but more frequent inland and toward the east. It fruits profusely, but practically no birds or mammals touch these. (Colius striatus, the "Muisvogel," occasionally partakes of the white fruits, and as a result its flesh tastes bitter.)

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* **Including Clematis Thunbergii Steud.**

Santalaceae.

Osyris abyssinica, woody shrub, forming consocies inland and on coast; Rhoiacarpos capensis, also a woody shrub, is far less frequent*; Thesium and Thesidium spp., semi-parasitic shrublets and herbs, are frequent, there being about twenty-five species of Thesium and three of Thesidium.

Sapindaceae.

Aitonia capensis, woody shrub with showy fruits, is occasional in the north of the region; Allophyllus decipiens (Schmidelia decipiens), A. erosus (S. erosa): small trees or large shrubs, very frequent in littoral scrub; Dodonaea Thunbergiana is a woody shrub frequent inland: it has showy fruits; Hippobromus alata occurs towards the east, but is much stunted. (A few larger specimens grow in the Keurbooms River Scrub Forest Reserve.)

Sapotaceae.

Sideroxylon inerme, stunted, malformed tree, especially frequent on the coast, where it forms important consocies and associes.

Scrophulariaceae.

Freylinia undulata, woody shrub in inland scrub; Halleria lucida, stunted tree or large shrub, widely distributed, but never very abundant in scrub; Harveya spp. occasionally occur as parasites on Erica and Phylica in open scrub; species of Melasma, Nemesia, and Sutera are also present, but are of little ecological importance.

Solanaceae.

Datura stramonium, ruderal shrub is frequent near human habitations, but is being eradicated; Lycium austrinum (unarmed), L. campanulatum, L. tetrandum (armed): woody shrubs forming dense thickets†; Nicotiana glauca, possibly exotic, widely spread in open scrub; Physalis minima, P. (peruvina) pubescens, are frequent in moister scrub; Solanum aggerum (prostrate coastal shrub), S. aculeastrum, S. aculeatissimum, S. capense, S. coccinium, S. giganteum, S. rigescens, S. sodomaeum, S. tomentosum: armed shrubs, varying from two to twelve feet in height; S. quadrangulare is an unarmed coastal climber, S. nigrum a naturalized undershrub, S. pseudocapsicum, a naturalized shrub bearing showy red fruits; the Solanaceae favour open sites in scrub, although S. giganteum can withstand dense shade.

Sterculiaceae.

Hermannia spp. occasionally occur in open inland scrub, especially H. leucophylla, H. salviaefolia, H. flammea, H. hyssopifolia: small herbs and shrubs.

Thymeleaceae.

Gnidia denudata, G. oppositifolia, Passerina filiformis, P. vulgaris (coastal), P. falcifolia, and Struthiola striata are the commonest representatives, often found in open scrub.

Tiliaceae.

Grewia occidentalis is a common scandent shrub.

Ulmaceae.

Celtis rhamnifolia occurs in inland and littoral scrub, chiefly along river banks; it is a stunted, deciduous tree.

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* Towards east, only.

† Particularly on saline soils.

Umbelliferae.

Heteromorpha arborescens, variable woody shrub, with polymorphic foliage; Peucedanum capense, small shrub; P. capillaceum, P. ferulaceum: herbs with acrid foliage. Hydrocotyle spp. are frequent along stream banks.

Urticaceae.

Fleurya mitis, herbaceous, with urticating hairs; Urtica urens, is a widely-spread, naturalized exotic; Droguetia ambigua, herb.

Verbenaceae.

Verbena bonariensis, exotic herb, to eight feet in height, frequent in open scrub; Lantana salviaefolia, a small semi-woody shrub, is found in scrub on the eastern limits of the region.

Vitaceae.

Rhoicissus capensis, R. digitata, R. cirrhosa, and Cissus cuneifolia are vine-like twiners of considerable importance in scrub, binding together the crowns of the stunted trees and shrubs.

Zygophyllaceae.

Zygophyllum flexuosum, Z. fulvum, Z. morgsana: small shrubs frequent in littoral scrub.

Ferns.

These are rare, the only widespread spp. being: Cheilanthes hirta v. contructa, Pellaea quadripinnata, P. viridis, Blechnum tabulare, Aspidium capense (stunted form), Asplenium bipinnatum (often epiphytic), Polypodium lanceolatum (often epiphytic).

Chapter VI.

THE CLIMAX HIGH FORESTS: FLORISTIC FEATURES.

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THE CLIMAX HIGH FORESTS—FLORISTIC FEATURES.

In comparison with the species of the macchia, forest plants proper are few. The principal forest plants are listed below, commencing with the Phanerogams.

Phanerogams.

1. *Gymnosperms.*

The Taxaceae are represented by Podocarpus elongata L'Herit. (P. falcatus, R.Br.), and P. Thunbergii Hook. (P. latifolius R. Br.). These trees play a most important part in the life-history of the forest.

P. elongata is the giant tree of South African forests, but is rarely abundant in one and the same locality (*vide* Podocarpus elongata consociation), it appears scattered throughout the forests.

P. Thunbergii, forming the true second story of the forest canopy, is either abundant or frequent in most forest communities.

Widdringtonia cupressoides, a small, badly grown tree, although more plentiful in certain portions of the macchia, may occasionally be found just within the forest margins.

2. *Angiosperms.*

(i) *Monocotyledons.*

The principal Monocotyledons normally found in climax forest are :—Haemanthus puniceus, H. albiflos (coastal), Vallota purpurea (in dense societies, producing a riot of scarlet in the flowering season, January to February), Carex aethiopica, Cyperus tenellus (in very dense societies on very moist sites), Ficinia capillifolia (very moist sites), F. leiocarpa (dry sites), F. sylvatica, Mariscus congestus (widespread, but more abundant on moist sites), Rhynchospora sp. nov. (very moist sites), Schoenoxiphium lanceum, S. sparteum (medium moist sites), Scirpus prolifer (very moist sites), Tetraria sylvatica, Stenotaphrum, glabrum, Oplismenus africanus, Aristea pusilla, Moraea iridioides (drier sites), Juncus lomatophyllus (moist sites), J. oxycarpus, Prionium palmita (along river beds), Agapanthus umbrellatus (drier forests, montane and coastal), Asparagus africanus, A. crispus (armed climbers), Asparagus plumosus, A. scandens (climbers), Chlorophytum comosum, Strelitzia augusta (rare west of Keurbooms River, frequent east of that river), Calanthe natalensis (terrestial or epiphytic), Acrolophia cochlearis, and the epiphytes, Listrostacahys arcuata, Angraecum bicaudatum, A. Burchellii, A. conchiferum, A. pusillum, A. sacciferum, Mystacidium filicorne, Polystachya Ottoniana. Bonatea speciosa occurs on opener moist sites, as occur Disa micrantha, D. cornuta, Disperis capensis, Satyrium retusum, S. bracteatum, Holothrix squamulosa.

Zantedeschia aethiopica (Richardia africana) forms large consocies and socies on moist, open sites, and smaller societies in moist, dark forest. A feature of moist, open sites is Wachendorfia thyrsiflora.

(ii) *Dicotyledons.*

The principal Dicotyledons commonly found in the forests are listed below—the families being arranged alphabetically :—

Acanthaceae.

Hypoestes verticillata forms extensive societies in drier forests. Isoglossa sylvatica is locally frequent.

Anacardiaceae.

Rhus laevigata (small tree, frequent in coastal and montane forest); R. lucida (large shrub, widespread); R. incana, R. tomentosa (medium-sized shrubs) occasionally occur in forest; the other Rhus spp. are not usually found in forest, being frequent in scrub and bush. Botryceras laurinum (Laurophyllus capensis) is a common, untidy woody shrub of the margins.

Apocynaceae.

Carissa arduina (small armed shrub, occasionally assuming a scandent habit); Gonioma Kamassi (small, but very valuable timber tree, occurs in all forests of the region, and in certain coastal forests as far east as East London, but does not occur at Alexandria*); Acokanthera venenata (medium-sized, woody shrub with poisonous latex and fruits, is rare in forests except certain coastal and montane ones).

Aquifoliaceae.

Ilex (capensis) mitis (large tree, frequent in moist sites).

Asclepiadaceae.

Secamone Alpini (liane forming thick woody stems rich in latex, much sought for food by elephants); Cynanchum obtusifolium (twiner), C. capense (twiner); Sarcostemma viminale (leafless, succulent twiner); Tylophora syringaefolia (twiner), T. sp. (twiner); Astephanus marginatus and A. neglectus are twiners. Although the number of species is small, the Asclepiadaceous lianes and twiners play an important part, in that they are abundantly developed, and knit together the branches and foliage of trees and shrubs into almost impenetrable tangles. They inhibit the growth and development of large numbers of young trees.

Araliaceae.

Cussonia thyrsiflora, occasionally grows in drier forest, as a weak, scandent shrub. C. umbellifera occurs in several forests (Witte Els Bosch Forest Reserve) on the upland plateau, in the district of Humansdorp. The trees are abundant in these forests, and assume full heights of from 40 to 50 feet, with clean boles of from 15 to 25 feet; they are from 10 to 20 inches in diameter when mature. Occasionally, small consociations are found, but usually the species is mixed with the usual forest trees. *Apart from this occurrence at Witte Els Bosch, C. umbellifera is not known to occur west of the St. John's River.*

Balsaminaceae.

Impatiens capensis (delicate herb forming dense societies in cool, moist sites); I. Duthiei (occurs sparingly in moist forests, forming small societies, or mixed with I. capensis).

Bixaceae.

Dovyalis (Doryalis) rhamnoides (armed woody shrub, more frequent in drier forests; often in small societies. The fruits are edible); Kiggelaria africana (medium-sized timber tree, varying much in leaf-form, according to locality, the leaves being larger and thinner in the inland forests, smaller and thicker and pubescent on the ventral surfaces, in the coastal); Scolopia Mundtii (small to medium-sized timber tree, locally frequent, but on the whole, a rare species. The boles may be either entirely unarmed or may show strongly

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* Recently recorded from the Mkandhla Forests, Zululand.

developed spines) ; S. Zeyheri* (very rare in the climax forests, a strongly armed tree of small dimensions) ; Trimeria alnifolia (small tree or large shrub) ; T. trinervis (shrub) has been recorded, but the writer has never seen this (*vide* Schonland, 1922†).

Campanulaceae.

Lobelia spp. occurs in lighter, moister sites, especially L. hirsuta, L. anceps, L. erinus var. bellidifolia, L. patula, L. tomentosa ; Wahlenbergia procumbens is frequent on moist sites. Lightfootia fasciculata.

Capparidaceae.

Capparis citrifolia (armed, scandent shrub, frequent in dry forest ; at times clambers to the crowns of Podocarpus elongata L'Herit.).

Niebuhria (Maerua) pedunculosa rarely occurs.

Celastraceae.

Cassine scandens (small, scandent shrub, frequent in drier forest, rare in main forests) ; Celastrus acuminatus (medium-sized timber tree, foliage very variable, according to locality) ; C. peduncularis (medium-sized timber tree) ; C. buxifolius and C. nemorosus (armed woody shrubs, leaves variable according to locality) ; Elaeodendron croceum (medium-sized tree) ; Elaeodendron capense (small tree) ; Elaeodendron Kraussianum (small to medium-sized timber tree, more common in coastal and montane forests of drier nature) ; Pterocelastrus variabilis var. variabilis (frequent throughout the forests, a medium-sized to large timber tree, may occur in consocies and consociations) ; Pterocelastrus variabilis var. rostratus is recorded from the George mountain forests‡ (*vide* Schonland, 1922, op. cit.) ; Hartogia capensis is a shrub to fifteen feet, frequent along the margins of many forests.

Cornaceae.

Curtisia faginea, the sole representative, is an important, medium-sized to large timber tree, frequent throughout the forests. [*vide* Phillips, 1928 ; (4)].

Cucurbitaceae.

Melothria (Zehneria) obtusiloba, M. hederacea, M. punctata are twiners, binding together the branches of the shrub layers.

Cunoniaceae.

Cunonia capensis is a large timber tree very abundant in moist forests on the plateaux and in the mountains ; it is often associated with Platylophus. Platylophus trifoliatus is an endemic monotype—a large timber tree, usually in consocies, or in associes with Cunonia as the other dominant [*vide* Phillips, J. F. ; 1925 ; (i)].

Droseraceae.

Drosera cuneifolia, an insectivorous herb, is frequent in moist sites.

Ebenaceae.

The only forest plants are :—Euclea lanceolata (shrub, scattered in littoral and montane forest) ; E. macrophylla (shrub or small tree, frequent in drier forest) ; Royena glabra (small shrub, frequent along margins) ; R. lucida (a medium-sized tree) ; R. pallens (variable shrub or small tree, common in drier forests).

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* Locally frequent in certain coastal forests.

† Manuscript preliminary check list, Vols. I-III, Flora Capensis.

‡ 1926. : This species has been collected from all the larger forests west of George by the writer.

Ericaceae.

The Ericaceae are frequent in burned and heavily exploited forest, but are not members of forest proper. The large E. canaliculata may be found in medial seral stages.

Compositae.

The only trees are : Brachylaena dentata (does not occur further west than Witte Klips Forest, a few miles west of Storms River ; a small to medium-sized tree) ; B. neriifolia (along river beds and on other moist sites, usually in consocies ; a large shrub or small tree) ; Tarchonanthus camphoratus (a small to medium-sized tree, usually commoner in coastal and montane forests). B. discolor is recorded from Storms River Pass, but has not been collected by the writer.

The more important larger, woody shrubs found on disturbed areas within the forests are :—Euryops virgineus, Metalasia muricata, Osteospermum corymbosum, O. moniliferum, which form dense communities.

Smaller composites commonly found are :—Aster spp. (ruderal) ; Athanasia spp. (ruderal) ; Bidens pilosa (mainly ruderal) ; Cryptostemma calendulaceum (ruderal) ; Dichrocephala latifolia (ruderal on moist sites) ; Elytropappus rhinocerotis (on drier sites only, ruderal) ; Euryops abrotanifolius var. intermedia (drier sites) ; Gerbera cordata, G. piloselloides, Helichrysum spp. (chiefly H. cynosum, H. felinum, H. foetidum, H. parviflorum, H. petiolatum (a rampant weed on most disturbed sites)] ; Helipterum eximium, Hippia frutescens (rampant weed on burnt sites) ; Hypochoeris radicata (ruderal) ; Leotonyx squarrosa, Peyrousea calycina, Senecio crenatus, S. glastifolius, S. ilicifolius, S. juniperinus, S. lyratus, S. lineatus ; Sonchus oleraceus (ruderal) ; Stoebe alopecuroides (disturbed sites only) ; S. cinerea (usually burnt sites) ; Ursinia anthemoides, Xanthium spinosum (ruderal) ; Osmites bellidiastrum (moist sites).

Lianes commonly found are :—Senecio angulatus, S. deltoideus (eastern portion of region) ; S. quinquelobus, S. mikanioides, Mikania capensis, Vernonia anisochaetoides.

Apart from the influence of such rampant weeds as Helichrysum and Bidens upon regeneration of tree species, the Composites are relatively unimportant in the forests.

Euphorbiaceae.

Cluytia pulchella (large shrub to fifteen feet in height); C. affinis, C. alaternoides, C. daphnoides, C. ericoides, C. laxa, C. polifolia, C. rubricaulis (smaller woody shrubs) ; the Cluytias are more frequent in disturbed forest than in natural ; they form dense communities useful as nurse stands to seedling trees. Ctenomeria capensis (twiner) ; Acalypha decumbens, A. glabrata, A. Ecklonii ; Adenocline mercurialis (shrubs). The monotypic small tree, Lachnostylis capensis, is frequent throughout the drier forests ; its leaves are very variable in size and shape, according to sex of tree and factors of the locality. Sapium Simii is a small shrub, frequent in dry coastal forests.

Gentianaceae.

Chironia jasminoides, C. malampyrifolia, C. peduncularis are perennial herbs, frequent under lighter canopy. Sebaea Grisebachiana, S. Brehmeri are annual or biennial herbs, in open sites.

Geraniaceae.

These rarely occur in normal forest ; several Pelargonium spp. are found in disturbed portions, being introduced by cattle.

Gesneraceae.

Streptocarpus Rexii (perennial herb, either epiphytic or terrestial).

Guttiferae.

Hypericum aethiopicum occassionally is found under lighter canopy, and along the margins.

Halorrhagaceae.

Laurembergia (Serpicula) repens (small herb, forming dense ground societies on moist ground): Gunnera perpensa (small, large-leafed herb, usually in moist places; pure or mixed with Laurembergia).

Hamamelidaceae.

Trichocladus crinitus (wide-spread woody shrub to eighteen feet in height, forming dense layer societies in medium-moist and dry forests): Trichocladus ellipticus (a common shrub of the eastern forests, but rare in the Knysna; occurs at Sourflats and at Gouna—sparingly).*

Icacinaceae.

Apodytes dimidiata (a large and important timber tree, present in most forest communities; is best developed in moist forest); Cassinopsis capensis (armed scadent shrub, most frequent in dry, open forest).

Pyrenacantha scandens is frequent in dry forests; it is a troublesome binder of under growth.

Labiatae.

Plectranthus fruticosus forms dense societies from two to four feet in height, in moist forest; P. Thunbergii is less frequent, and smaller Stachys Thunbergii, a hispid, untidy rambler, forms small societies.

Lauraceae.

Cassytha ciliolata (parasitic twiner, with leaves reduced to scales, uniseriate haustoria, and no chlorophyll; attacks various hosts, notably, among trees, Virgilia capensis and Ocotea bullata); Ocotea bullata (large and most valuable timber tree; occurs on occasion in small consociations, but is usually mixed with other tree species; develops best in moist forests; coppices freely).†

Leguminosae.

Cassia occidentalis, C. tomentosa, small trees or large shrubs, frequent in consocies, or associes, usually in open forest; these are exotics in all probability. Crotalaria spp.‡, Podalyria spp., Psoralea spp. occasionally grow in open forests, but do not belong to the forest flora proper. Schotia latifolia is a rare, small tree in coastal forest in the Zitzikamma and near Plettenberg Bay. S. speciosa is recorded from the same localities, but has not been seen there.

Trifolium repens is a widely spread exotic in all forests that have been exploited or grazed. Dolichos gibbosus is a poisonous climber, frequent in open forest; Fagelia bituminosa is a common twiner in coastal forest; Virgilia capensis, a tree from 20 to 60 feet high and from 6 to 24 inches in diameter, rarely occurs in high forest, but is frequent in late seral stages. Erythrina caffra reaches the Kromme River forests in the Zitzikamma.

Lentibulariaceae.

Utricularia capensis, a delicate herb, grows on moss cushions in moist forests.

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* About 6 individuals in all are known to the writer.

† *Vide* Phillips, 1924 (1).

‡ Especially Crotalaria purpurea.

Loganiaceae.

Buddleia salviaefolia (small, badly shaped tree, frequent in seral stages); Chilianthus arboreus (small tree more common in the coastal forests); Nuxia floribunda (medium to large, badly shaped tree, frequent in medium-moist and moist forest).

Strychnos Atherstonei is recorded from the extreme east of the region, in the Humansdorp Division, but has not been seen by the writer.

Loranthaceae.

Viscum obscurum (chiefly parasitic on Olea laurifolia and Platylophus trifoliatus).

Lythraceae.

Lythrum hyssopifolium (frequent in moist places under light canopy; not a forest plant proper, but introduced).

Malvaceae.

Abutilon Sonneratianum, Malvastrum calycinum, Pavonia mollis, Sida triloba (small fibrous shrubs) occur, but Malvaceae are better represented in littoral scrub and bush. (Hibiscus pedunculatus is locally frequent in dry forests.)

Meliaceae.

Ekebergia capensis (medium to large forest tree, more frequent in coastal forest, where it may be found in consocies; in the main forests it is scattered) this species varies much in the form of its leaflets. [*Vide* Phillips, 1927: (4).]

Menispermaceae.

Antizoma capensis, Cissampelos torulosa, are twiners occasionally found in high forest.

Moraceae.

Ficus capensis (*cauliflorous*, small to medium-sized tree, or weak, scandent shrub, sometimes *epiphytic-parasitic** on other trees); F. Burtt-Davyi (similar in its growth-forms to the former species), is more frequent in the Zitzikamma Forests and in the coastal forests.

Myricaceae.

Myrica conifera (small shrub, occurs sparingly in coastal and montane forests).

Myrsinaceae.

Myrsine africana (marginal shrub or very small tree; more frequent in coastal and montane forests); M. melanophleos (medium to large tree, often in consocies; may form associes with any other forest trees; is an important species in the penultimate seral stages).

Ochnaceae.

Ochna arborea (small tree); O. atropurpurea (shrub, rare in the main, but frequent in the coastal forests).

Oleaceae.

Olea capensis (large shrub or small tree); O. foveolata (small tree); O. laurifolia (large tree, frequent in most forests, but varying much in size and development according to locality; with Podocarpus Thunbergii Hook, one of the most important species of the forests).

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* i.e. commences life as an *epiphyte*, but gradually assumes the rôle of a *parasite*.

Oliniaceae.

Olinia cymosa (medium to large tree, found in consocies and associes; is especially frequent in drier forests; for details of biology *vide* J. F. Phillips, 1926; (i)].

Oxalidaceae.

Oxalis convexula, O. incarnata are the most important forest species in this family.

Piperaceae.

Peperomia reflexa, P. retusa (epiphytic or terrestial, perennial herbs); Piper capense (lax shrub, frequent in moist forests).

Pittosporaceae.

Pittosporum viridiflorum is scattered in coastal and montane, but does not occur in normal forest, except in several patches at Jonkersburg, twenty miles west of George.

Polygalaceae.

Polygala myrtifolia (large, weak shrub, frequent in coastal forest; occasional on open sites in main forests); the smaller P. oppositifolia occurs in like localities.

Polygonaceae.

Polygonum acuminatum var. capense (herb, in moist places); P. senegalense (tall shrub, frequent in disturbed forest; probably an exotic); Rumex acetosella is a widely spread exotic, in moist sites; R. sagittatus is a handsome climber, frequent in open sites.

Proteaceae.

Large Protea and Leucadendron species, e.g., P. Mundtii, P. lacticolor, L. eucalyptifolium, L. salignum, occasionally grow in medial and penultimate stages, but are not present in climax forest.

Faurea McNaughtonii,* a large timber tree is found in one forest only, that of "Lilyvlei," Gouna Reserve, Knysna Division; in this locality the trees are very abundant, and the regeneration of all stages excellent.

Faurea is another example of discontinuous distribution—it being known from several widely separated Transkeian forests, and from one forest in Natal only, apart from its occurrence at Gouna.

Ranunculaceae.

Clematis brachiata (a woody liane, abundant throughout the forests; much sought for food by elephant; Knowltonia glabricarpellata, K. rigida, K. vesicatoria (rigid, herbaceous shrubs, forming layers from one to three feet high, especially in drier forests); Ranunculus pinnatus (herb, very common in moist places, forming small ground-societies); several exotic species of Ranunculus are to be found in forest, occasionally.

Rhamnaceae.

Rhamnus prinoides (small or large woody shrub, frequent under lighter canopy); Scutia indica (S. Commersonii) is a troublesome, armed, scadent shrub which often takes the form of a woody liane and strangles young and old trees.

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* *Vide* J. F. Phillips, 1927 (1).

Rosaceae.

Cliffortia odorata (a prostrate, herbaceous shrub, forming dense communities under open canopy, in moist sites; is also abandant along the margins; when virile, forms an excellent natural fire-resister); Pygeum africanum (a large timber tree, occurs as a rarity in the Blaauwkrantz Pass Forest*); Rubus fruticosus [introduced into the Storms River Forest in 1856, has since spread throughout the region, forming impenetrable communities from three to over ten feet in height wherever sufficient light is available: it has been spread by human and lower animal (especially elephant in the Knysna Division) agencies]; R. pinnatus is a weak rambler, abler to grow under low light-intensities: R. rigidus, so common in scrub, is rare in high forest.

Rubiaceae.

Anthospermum aethiopicum, A. ciliare (herbs, occasionally found inside the forests); Burchellia capensis (large woody shrub or small tree; a prominent member of the lower tree layers in high forest); Galopina circaeoides (weak herb, frequent throuhgout the forests); Gardenia Rothmannia (small tree, scattered, in drier forests, produces a showy, sweetly scented flower); Plectronia Mundtii (small tree) P. obovata (medium-sized tree, with marked buttressess and flutings); P. ventosa (a spiny, woody shrub, frequent in drier, opener forests); P. spinosa (of the same habit as the former plant; occurs sparingly, but increases as the eastern limit of the region is approached); Psychotria capensis (large shrub, found in "Lilyvlei" Forest, Gouna Reserve, Knysna Division, only, in the region under description, but well represented in the eastern and Natal forests). (Plectronia pauciflora Klotz.—Flora Cap., III; 18—has not been collected.)

Rutaceae.

Calodendron capense (medium tree, rare in main, frequent in coastal forests; produces mauve, rhododendron-like flowers); Clausena inaequalis (weak shrub, occurs in drier coastal and inland forests); Fagara capense (small tree or large shrub, chiefly in coastal forests); F. Davyi (tree, occasional in main forests, but common in coastal); Empleurum serrulatum (shrub to twenty feet in height, frequent along rivers, and at higher altitudes). Toddalia (vepris) lanceolata, a small tree, occurs sparingly.

Santalaceae.

Osyris Abyssinica; (Colpoon compressum), is frequent in open sites in coastal and montane forests, but rarely grews in the main forests.

Sapindaceae.

The only forms occurring in forests are:—The large woody shrubs or small trees Allophyllus (Schmidelia) decipiens; A. erosus (Schmidelia erosa); Hippobromus alata (east of Keurbooms River).

Sapotaceae.

Sideroxylon inerme (medium-sized tree, or badly shaped shrub, frequent in coastal and montane forest, very rare in main forests).

Scrophulariaceae.

Halleria lucida (small tree or large shrub, often in consocies, on lighter-canopied sites; is a member of the lower tree layers; cauliflory is exhibited); Melasma sessiliflorum (herb, parasitic on shrub roots; rare in forests); Sutera app. (procumbent herbs; frequent in moist, opener sites).

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* About 20 trees have been located by the writer, 1926.

Solanaceae.

Physalis (peruviana) pubescens (exotic, herbaceous shrub, occurs sparingly in opener forest); Solanum giganteum (a shrub to fifteen feet in height); S. nigrum (herbaceous rambler); S. aculeastrum, S. sodomaeum, S. tomentosum (spiny shrubs, exotics); the Solanaceae are either exotics or ruderals, introduced to the forests by elephant and cattle.

Thymeleaceae.

Gnidia denudata (fibrous shrub, frequent along elephant paths); Passerina falcifolia (shrub to fifteen feet in height, frequent along margins); P. filiformis (shrub to ten feet), locally frequent in drier forests.

Tiliaceae.

Grewia occidentalis (woody scrambler, rare in main forests, but frequent in coastal and montane forests).

Sparmannia africana (an important, fibre-producing shrub, attaining heights of from ten to fifteen feet).

Ulmaceae.

Celtis rhamnofilia (medium-sized tree, frequent along rivers).

Umbelliferae.

Heteromorpha arborescens (large shrub, with variable leaves, frequent in coastal and montane forests); Hydrocotyle asiatica (herb, frequent in moist places).

Urticaceae.

Fleurya mitis (herb, with urticating hairs; locally frequent); Urtic aurens (locally frequent; exotic).

Vitaceae.

The vine-like climbers, Rhoicissus capensis, R. digitata, Cissus cuneifolia are frequent in coast, disturbed main, and montane forests; R. capensis is detrimental to crown-development of many young trees.

Cryptogams.

1. *Pteridophytes.*

The more important forest ferns listed are:—Trichomanes pyxidiferum (moist banks and tree trunks); Hymenophyllum tunbridgense (moist banks and tree trunks); Hemitelia capensis (ten to twelve feet high, forming extensive layer-societies in moist forest); Dryopteris Bergiana, D. africana, D. lanuginosa (small ferns of moist sites); Polystichum aculeatum, P. pungens, P. adianteforme (hardy ferns several feet high, found on drier soils); Asplenium monanthes; A. lunulatum; A. protensum; A. gemmiferum (this plant is often epiphytic); A. bipinnatum (this plant is often epiphytic); A. theciferum; A. cuneatum*; A. praemorsum; A. solidum. Blechnum australe, attenuatum; B. punctulatum; B. tabulare† (ferns frequently on drier soils); B. capense (frequently on moister sites). Pellaea quadripinnata; P. viridis (drier sites). Cheilanthes hirta (dense shade); Hypolepis sparsiora; H. Bergiana (moist sites); Adiantum capillus-veneris (local; along stream-banks); Pteris cretica; P. Buchanani (these are frequent in moist sites). Lonchitis pubescens (humid sites). Pteridium aquilinum (widespread, but best developed where light is strong).

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* Sometimes epiphytic.

† More abundant and finer in Montane Macchia.

The following are usually epiphytic:—Polypodium polypodioidies; P. ensiforme; P. lineare; P. lanceolatum; P. lanceolatum var. sinuatum; Elaphoglossum conforme; E. petiolatum.

Gleichenia polypodioides forms extensive consocies, reaching many feet in height. Osmunda regalis (occasional, moist sites): Todea barbara (moist sites along river-banks); Marattia fraxinea (six to eight-feet fronds; mixed with Hemitelia).

The Lycopodiales are represented by the epiphytic Lycopodium Gnidioides, the small L. Carolinianum, and the prostrate, extensively developed L. cernuum.

2. *Mosses.*

There are numerous mosses, some of which have not as yet been described*, but the more important ones, ecologically, are as follows:—Ectropothecium regulare; Funaria hygromtrica; Hypopterygium laricinum; Papillaria africana; Plagiochila natalensis; Polytrichum commune; Polytrichum juniperinum; Porothamnium pennaeforme (draping the crowns of trees in moist places); Rhacopilum capense; Rhizogonum spiniforme; Syrrhopodon pomiformis; in addition, species of Microthamnium, Camylopus, Macromitrium, and Fissidens.

Apart from providing moisture-containing coverings to tree trunks and soils in many portions of the forests, the mosses do not appear to play an appreciable part in the forest-ecology. They certainly require more study than the writer has been able to give them.

3. *Fungi.*

The more important parasitic and saprophytic fungi occurring in the forests are the following:—

(a) *Parasitic Fungi.*

Fungus.	Host.	Remarks.
ASCOMYCETES.		
Perisporiaceae—		
Dimerium intermedium...	Streptocarpus Rexii..........	Causes loss of assimilative surface.
Meliola amphitricha.......	Olea laurifolia................	Loss of assimilative surface, yellowing of leaves, often followed by death of part or whole of the infected leaf.
Meliola comata...........	Pyrenacantha scandens........	Loss of assimilative surface, yellowing of leaves, often followed by death of part or whole of the infected leaf.
M. Evansii..............	Elaeodendron croceum........ E. capense	Loss of assimilative surface, yellowing of leaves, often followed by death of part or whole of the infected leaf.
M. falcata..................	Plectronia ventosa............	Loss of assimilative surface, yellowing of leaves, often followed by death of part or whole of the infected leaf.
M. ganglifera.............	Curtisia faginea..............	Loss of assimilative surface, yellowing of leaves, often followed by death of part or whole of the infected leaf especially in young seedlings.
M. Hendeloti.............	Nuxia floribunda.............	Loss of assimilative surface, yellowing of leaves, often followid by death of part or whole of the infected leaf especially in young seedlings.
M. manca.................	Rubus spp....................	Loss of leaves occasionally.
M. Oleicola..............	Olea laurifolia................ Olea capensis Olea foveolata	Occasional loss of leaves; seedlings suffer most.
M. peltata...............	Podocarpus Thunbergii........	Leaves seldom die; seedlings seldom are infected.
M. Rhois.................	Rhus spp.....................	Badly-infected leaves die slowly.
Pilene africana...........	Olea capensis.................	Slight loss of assimilative surface.
Englerulaceae—		
Diathrypton radians......	Cunonia capensis.............	Slight loss of assimilative surface; occasional death of portions of leaves.
Parenglerula MacOwaniana	Elaeodendron Kraussianum....	Slight loss of assimilative surface; occasional death of portions of leaves.

* Mosses: Specimens sent to Dr. T. R. Sim for identification.

(a) *Parasitic Fungi*—(continued).

Fungus.	Host.	Remarks
ASCOMYCETES—(Contd).		
Montagnellaceae—		
Diplochorella amphimelaena	Osyris abyssinica..............	Loss of leaves when severe.
Polystomellaceae—		
Hysterostoma capense....	Olea capensis................	Loss of assimilative surface.
H. Faureae..............	Faurea McNaughtonii.........	Loss of assimilative surface.
Hysterostomina Eucleae....	Euclea macroglossa...........	Loss of assimilative surface.
Microthyriaceae—		
Asterina celtidicola.......	Kiggelaria africana...........	Loss of assimilative surface; and occasional death of leaves.
A. delicata.................	Trimeria alnifolia.............	Loss of assimilative surface; and occasional death of leaves.
A. gerbericola.............	Gerbera piloselloides..........	Loss of assimilative surface; and occasional death of leaves.
A. Grewiae..............	Grewia occidentalis...........	Loss of assimilative surface; and occasional death of leaves.
A. reticulata.............	Olinia cymosa................	Loss of assimilative surface; and occasional death of leaves.
A. rhamnicola............	Rhamnus prinoides...........	Loss of assimilative surface; and occasional death of leaves.
Asterinella dissiliens......	Elaeodendron croceum........	Loss of assimilative surface.
A. Burchelliae............	Burchellia capensis...........	Loss of assimilative sufrace.
A. Pterocelastri...........	Pterocelastrus variabilis.......	Loss of assimilative surface.
Capnodium spp. (many)...	All spp. of trees and shrubs..	Loss of assimilative surface.
Englerulaster Gymnosporiae	Celastrus buxifolius (Gymnosporia buxifolia)	Loss of assimilative surface.
E. orbicularis..............	Ilex (capensis) mites..........	Loss of assimilative surface.
Morenoella Phillipsii......	Ocotea bullata seedlings......	Loss of assimilative tissue, death of leaves, and drying of young stems.
Dothideaceae—		
Asterodothis solaris.......	Olea laurifolia................ Elaeodendron croceum	Loss of assimilative tissue, and death of leaves (*vide* J. F. Phillips, 1923).
Coryneliaceae—		
Corynelia fruticola........	Myrsine melanophleos fruits...	Destroys germules.
C. uberata...............	Podocarpus Thunbergii podocarpia	Destroys embryo.
Tripospora tripos.........	Podocarpus elongata L'H. foliage	Does slight harm to the leaves, if very abundant.
BASIDIOMYCETES.		
Uredineae—		
Endophyllum [Macowanianum	Rhamnus prinoides...........	When severely attacked, the leaves become yellow.
Pucciniaceae—		
Aecidium Baumii.........	Plectronia Mundtii............	Slight harm to the foliage.
A Englereanum..........	Clematis brachiata............	Slight harm to foliage.
A. oxalidis...............	Oxalis breviscapa............	Slight harm to foliage.
Caeoma clematidis.......	Clematis brachiata............	Hypertrophy of stem and leaves.
Phragmidium albidum....	Rubus fruticosus............	Often kills foliage.
Uromyces cyperi.........	Cyperus spp.................	Does slight harm.
Thelephoraceae—		
Stereum hirsutum........	Olea laurifolia................	On wounded trees; commences as a saprophyte, and attacks living tissue later.
Corticium vagum (Rhizoctonia solani)	Olea spp.; Apodytes dimidiata; Ocotea bullata seedlings	Produces a severe root-rot (*vide* J. F. Phillips, 1923).
Polyporaceae—		
Fomes applanatus........	All species of trees, but particlarly Olea laurifolia	Decay of, and ultimate death of trees.
F. geotropus.............	Ocotea bullata chiefly, but also on various other timber trees.*	Produces decay of tree.
F. hornodermis..........	Ocotea bullata..............	Produces decay of tree.
F. rimosus..............	Elaeodendron croceum and other trees	Produces decay of tree.
F. oroflavus.............	Curtisia faginea..............	Produces decay of tree.
F. Robinsoniae..........	Gonioma Kamassi............	Produces decay of tree.
Fomes Yucatensis........	Curtisia faginea..............	Slight decay of tree.
Polyporus grammocephalus	Nuxia floribunda.............	Very slight decay of tree.
P. sulphureus............	Olea laurifolia................	Slight decay; rare.
Trametes protea..........	Curtisia faginea..............	Slight decay.
Trametes glabrescens.....	Curtisia faginea..............	Very slight decay.
Agaricaceae—		
Schizophyllum commune..	Olinia cymosa and various other trees	Slight decay of tissue near wounds.

* Podocarpus Thunbergii particularly.

Fungus.	Host.	Remarks.
FUNGI IMPERFECTI.		
Coniothyrium insigne.....	Ocotea bullata...............	Loss of leaf tissue.
Pestalozzia spp...........	(1) Flowers of Ocotea bullata..	Sp. nov., attacks the stigma, style, ovules. (J. F. Phillips, 1924) (i).
	(2) Fruits of Ocotea bullata...	Sp. nov., attacks the drupes, causing decay thereof. (J. F. Phillips 1924)(i).
Fusarium spp. (many)....	Various spp. of tree seedlings, but chiefly Podocarpus spp. Very severe in nurseries	Death of seedlings.

(b) *Saprophytic Fungi.*

Fungus.	Remarks.
ASCOMYCETES.	
Hypocreaceae—	
Nectria Peziza...............	Assists in decomposing old wood.
Xylariaceae—	
Daldinia concentrica..........	Assists in decomposing old wood but very occasionally is paras'tic Halleria lucida stems.
Nummularia lepidea..........	Assists in decomposing old wood.
N. punctulatum..............	Assists in decomposing old wood.
Xylaria apiculata.............	Assists in decomposing old wood.
X. corniformis...............	Assists in decomposing old wood.
X. hippoglossa...............	Assists in decomposing old wood.
X. polymorpha...............	Assists in decomposing old wood.
X. reticulata................	Assists in decomposing old wood.
X. Schweinitzii..............	Assists in decomposing old wood.
X. tabacina.................	Assists in decomposing old wood.
BASIDIOMYCETES.	
Tremellaceae—	
Exidia caespitosa.............	Assists in decomposing old wood.
Tremella crassa..............	Assists in decomposing old wood.
T. frondosa..................	Assists in decomposing old wood.
T. fuciformis.................	Assists in decomposing old wood.
T. lutescens.................	Assists in decomposing old wood.
T. mesenterica...............	Assists in decomposing old wood.
Dacryomycetaceae—	
Dacryomyces deliquescens......	Assists in decomposing old wood.
D. digressus.................	Assists in decomposing old wood.
Guepinia spatularia...........	Assists in decomposing old wood.
Thelephoraceae—	
Cladoderris spongiosa*........	Assists in decomposing old wood.
Stereum fuscum..............	Assists in decomposing old wood.
S. Kalchbrenneri.............	Assists in decomposing old wood.
S. lobatum..................	Assists in decomposing old wood.
Clavariaceae—	
Clavaria cyanocephala.........	Locally abundant, on sawdust.
Hydnaceae—	
Hydnum sp. resembling H. erinaceum	On decaying boles of Olea laurifolia.
Irpex vusco-violaceae..........	Decays old wood.
I. vellereus....................	Decays old wood.
Polyporaceae—	
Daedalia stereoides...........	Decays old wood, especially O. laurifolia.
Hexagona albida.............	Decays old wood; not very common.
Laschia rubella..............	Decays old wood; not very common.
Lenzites betulina............	Decays old wood; very common.
L. repanda..................	Decays old wood; very common.
Polyporus australiensis........	Decays old wood.
P. cinnabarinus..............	Decays old wood.
P. conchoides................	Decays old wood.
P. gilvus....................	Decays old wood.
P. hirsutus..................	Decays old wood.
P. lucidus...................	Decays old wood.
P. ostreiformis...............	Decays old wood.
P. sanguineus................	Decays old wood.
P. Telfairii..................	Decays old wood.
P. velutinus.................	Decays old wood.
P. versicolor................	Decays old wood.
P. zonatus..................	Decays old wood.
Trametes hispida.............	Decays old wood.
T. Hystrix...................	Decays old wood.
T. obstinatus................	Decays old wood.

* Frequent in *moist* forests only.

Fungus.	Remarks.
Bloeteae—	
Boletus bovinus	Frequent on humus soil.
Agaricaceae—	
Agaricus campestris	Frequent in Forests frequented by cattle and elephant.
Lentinus Lecomtei	Frequent on old wood.
L. Sajor-Caju	Frequent on old wood.
Lepiota procera	Frequent on soil rich in humus.
Hymenogastraceae—	
Octaviana carnea	Frequent on soil rich in humus.
Sclerogaster africana	Frequent on soil rich in humus.
Lycoperdaceae—	
Battarea phalloides	Frequent on soil rich in humus.
Tulostoma cyclophorum	Frequent on soil rich in humus.
Arachnion album	Frequent on soil rich in humus.
Scleroderma cepa	Frequent on soil rich in humus.
S. tenerum	Frequent on soil rich in humus.
S. verrucosum	Frequent on soil rich in humus.
S. vulgare	Frequent on soil rich in humus.
Mycenastrum corium	Frequent on soil rich in humus.
Bovistella aspera	Frequent on soil rich in humus.
Lyncoperdon gemmatum	Frequent on soil rich in humus.
L. oblongisporum	Frequent on soil rich in humus.
Nidulariaceae—	
Cyathus Berkeleyanus	Frequent on old wood, especially Podocarpus.
C. microsporus	Frequent on old wood, especially Podocarpus.
C. Montagnei	Frequent on old wood, especially Podocarpus.
C. pallidus	Frequent on old wood, especially Podocarpus.

The fungi play an important role in the life-history of the forest. The parasitic fungi have a directive influence in regeneration processes, the most important part in this connection being played by the Perisporiaceae and Microthyriaceae. Adult trees are often killed gradually by parasitic Polyporaceae.* The saprophytic fungi, on the other hand, are directly useful in that they decompose wood, bark, and foliage, and thus enrich the soil.

A feature of the greatest significance is brought out when the tree and shrub and liane flora of the Knysna Forests is compared with the flora of the forests further east: there is a steady decrease in species as the west is approached. The Natal forests are richer floristically than those of the Transkei, the Transkeian are richer than the Kaffrarian, the Kaffrarian contain more species than do the Alexandrian, the Alexandrian show species that do not occur at Knysna. On the other hand, the Knysna forests are richer than the relict patches at Swellendam, and the latter contain more species than do the relicts in the Cape Peninsula kloofs. Marloth (1908: 200) draws attention to these facts, but the figures given by him—thirty-five of the fifty forest trees of the eastern forests occur at Knysna, twenty-six at Swellendam, and eighteen in the Cape Peninsula —require some modification now that better records of distribution are available.

An examination of the forest-floras of Natal, the Transkei, the eastern Cape Province, and of the Knysna region yields the following points of interest:—

1. *There are about* 130 *species of trees, woody shrubs, woody lianes, common to the forests of Natal, the Transkei, and the eastern Cape Province, that do not occur within the Knysna region.* These are as follows: Popowia caffra, Capparis albitrunca, Niebuhria caffra, Cadaba natalensis, Dovyalis tristis, D. rotundifolia, Grewia flava, Cassinopsis tinifolia, Hibiscus tiliaceus, Dombeya Dregeana, D. cymosa, Erythroxylon monogynum, Toddalia† natalensis, Commiphora caryaefolia, C. Harveyi, Turraea obtusifolia, Trichilia emetica (as far east as East London), Ptaeroxylon utile, Allophyllus monophyllus, Sapindus oblongifolius, ‡Zizyphus mucronata, Pleurostylia capensis, Gymnosporia cordata,

* **Especially by** *F. applanatus* and *F. geotropus.*
† Toddalia natalensis now is Teclea natalensis Eng.
‡ *Greyia Sutherlandi.*

G. angularis, G. undata, G. albata, G. spp. (three or four, uncertain), Protorhus longifolia, Rhus spp. (twenty-nine spp. occur in Natal, Transkei, and east, fifteen only at Knysna), Harpephyllum caffrum (Odina caffra), Dalbergia armata, D. obovata, Erythrina humeana (E. caffra just reaches the eastern limit of the Knysna region—Kromme River), Calpurnia sylvatica, Schotia speciosa (recorded from Knysna region, but not seen—doubtful), Entada natalensis, Acacia caffra, A. hirtella, A. horrida (just reaches eastern limit of Knysna region), Leucosidea sericea, Choristylis rhamnoides, Homalium rufescens, Combretum salicifolium, Weihea madagascariensis, Eugenia cordata, E. Zeyheri, E. capensis, Gardenia globosa, G. neuberia, G. Thunbergia, Randia rudis, Pavetta lanceolata, P. obovata, P. caffra, Kraussia lanceolata, Plectronia cil ata, Vangueria infausta, V. macrocalyx, V. venosa, Brachylaena elliptica, B. discolor, B. racemosa, Maesa alnifolia, Chrysophyllum natalense, Mimusops obovata, M. caffra, M. marginata, Royena villosa, Maba natalensis, Euclea undulata, Olea Woodiana, Jasminum multipartitum (J. glaucum, J. angulare, just touch the eastern limit of the Knysna region), Strophanthus speciosus, Strychnos Henningsii, S. speciosa, Nuxia congesta, *Chilianthus dysophyllus*,* Ehretia Hottentotica, Cordia caffra, Bowkeria simpliciflora, B. triphylla, Tecomaria capensis, Clerodendron glabrum, Vitex obovata, Xymalos monospora, Cryptocarya acuminata, C. Woodii, Peddiea africana, Dais cotinifolia, Osyridocarpos natalensis, Chaetachme aristata, Trema bracteolata, Ficus ingens, Croton rivularis, C. gratissimus, Cluytia Katherinae, C. natalensis, C. hirsuta, C. heterophylla, Euphorbia triangularis, E. tetragona, E. grandidens (these tree Euphorbias just touch eastern limit of Knysna region), Gelonium africanum, Acalypha peduncularis, Sapium Simii, Phyllanthus glaucophyllus, P. maderaspalensis, Encephalartos Lehmanni, Encephalartos Altensteinii, E. longifolius.

2. *There are about 130 species of trees, woody shrubs, woody lianes, common to the forests of Natal, the Transkei, the eastern Cape Province, and the Knysna region.* These are as follows: Clematis brachiata, Knowltonia vesicatoria, Niebuhria pedunculosa, N. triphylla, Capparis Guenzii, C. citrifolia, Scolopia Mundtii, S. Zeyheri, S. Ecklonii (just reaches eastern limit of Knysna), Kiggelaria africana, Dovyalis rhamnoides, Trimeria alnifolia, T. trinervis, Apodytes dimidiata, Cassinopsis capensis, Polygala myrtifolia, P. oppositifolia, Pittosporum viridiflorum, Abutilon Sonneratianum, A. indicum, Grewia occidentalis, Ilex capensis, Toddalia lanceolata, Clausena inaequalis, Calodendron capense, Ochna arborea, O. atropurpurea, Ekebergia capensis, Allophyllus erosus, A. decipiens,† *Pappea capensis (scrub forests)*‡, Scutia indica, Rhamnus prinoides, Noltea africana (scrub forests), Rhoicissus capensis, R. cirrhiflora, R. digitata, Cissus cirrhosa, Celastrus buxifolius, C. nemorosus, C. procumbens, C. polyacanthus, Celastrus acuminatus, C. peduncularis, Elaeodendron croceum, E. capense, E. Kraussianum [and in coast forests, Elaeodendron (Mystroxylon) aethiopicum, E. (M.) sphaerophyllum], Rhus laevigata (R. dentata, R. lucida, R. excisa, R. puberula, R. pyroides, R. obovata, R. crenata, commoner in scrub), Psoralea pinnata, Erythrina caffra (just reaches eastern limit of the Knysna region), Schotia latifolia (rare tree in coastal forests, Knysna), Cassia tomentosa, C. occidentalis, Pygeum africanum (rare tree, Zitzikamma), Cunonia capensis, Trichocladus crinitus, T. ellipticus (rare shrub, Knysna), Cussonia umbellifera (local, Zitzikamma), C. spicata (just reaches scrub, eastern limit of Knysna region, and in the Longkloof), Heteromorpha arborescens, Secamone Alpini, Curtisia faginea, Gardenia Rothmannia, Burchellia capensis, Psychotria

* *In scrub on Eastern limit.*
† Hippobromus alata.
‡ Pappea capensis in Eastern scrub.

capensis, Plectronia ventosa, P. spinosa, P. obovata, P. Mundtii, **P. pauciflora*, Osteospermum moniliferum, Tarchonanthus camphoratus, Senecio deltoideus (eastern portion of Knysna region), S. macroglossa (eastern portion of Knysna region), S. mikanioides, Mikania capensis, Myrsine africana, M. melanophleos, Sideroxylon inerme, Royena lucida, R. cordata, R. hirsuta, R. pallens, Euclea lanceolata, E. multiflora, E. macrophylla, Olea capensis, Olea laurifolia, O. foveolata, O. verrucosa, Azima tetracantha (rare), Carissa arduina, Acokanthera venenata, Nuxia floribunda, Chilianthus arboreus, Buddleia salviaefolia, Halleria lucida, Ocotea bullata, Osyris abyssinica, Celtis rhamnifolia, Ficus capensis, Ficus Burtt-Davyi, Cluytia pulchella, C. affinis, C. laxa, C. Dregeana, Acalypha glabrata, A. Ecklonii, Andrachne ovalis, Salix capensis var. mucronata, Myrica conifera, Piper capense, Podocarpus Thunbergii, P. elongata, Widdringtonia cupressoides, Encephalartos caffer (reaches the eastern limit of the Knysna region), Strelitzia augusta.

3. *There are about 20 to 25 species more or less peculiar to the Knysna region.* They are: Sparmannia africana, Empleurum serrulatum, Dodonaea Thunbergianum, Hartogia capensis, Botryceras laurinum, Virgilia capensis, Platylophus trifoliatus (extends to Swellendam),† Cussonia thyrsiflora, Myrsine gilliana, Royena glabra, Euclea acutifolia, E. polyandra, E. racemosa, Olea exasperata, Gonioma Kamassi (occurs sparingly as far as East London),‡ Freylinia undulata, Cluytia polifolia, C. pubescens, C. rubricaulis, Lachnostylis capensis, Myrica Burmannii.

4. *There are about sixty species common to the Natal and Transkeian Forests that do not reach the Eastern Forests and those of the Knysna.* They are: Niebuhria Woodii, Capparis Woodii, Rinorea ardisaeflora, Garcinia Gerrardi, Rawsonia lucida, Cola natalensis, Grewia lasiocarpa, Acridocarpus natalitius, Ochna Holstii, Allophyllus melanocarpus, Bersama lucens, Erythrina tomentosa, Milletia caffra, M. Sutherlandii, Albizzia fastigiata, Combretum erythrophyllum, C. Kraussi, Poivrea bracteosa, Rhizophora mucronata, Bruguiera gymnorhiza, Cassipourea verticillata, Eugenia Gerrardi, Oxyanthus Gerrardi, Alberta magna, Tarenna pavettoides, Plectronia Guenzii, Tricalysia capensis, Tarchonanthus trilobus, Maesa lanceolata, Carissa grandiflora, Rauwolfia natalensis, Conopharyngia ventricosa, Embelia ruminata, Buddleia pulchella, Anastrabe integerrima, Ruttya ovata, Mackaya bella, Adhatoda duvernoia, Vitex mooiensis, Avicennia officinalis, Cryptocarya latifolia, Ficus craterostoma, Croton sylvaticus, Cluytia virgata, C. glabrescens, C. coedata, C. disceptata, Antedesma venosum, Macaranga capensis, Notobuxus natalensis, Acalypha petiolaris, A. punctata, A. Wilmsii, Sapium Mannianum, S. reticulatum, Spirostachys africana, Phyllanthus discoideus, P. myrtaceus, P. Meyerianus Drypetes arguata, D. Gerrardii, Olinia radiata, Cardiospermum halicacabum.

5. *There are very few species occurring in the Transkeian and Eastern Cape Province Forests that do not occur in Natal.* These species do not occur at the Knysna. They are as follows: Dovyalis caffra, Greyia Flanagani, Ochna natalitia, Rhus mucronifolia, Rhus discolor, R. glaucescens, Pavetta Bowkeri, Royena lycioides, Euclea coriacea.

6. There are several interesting examples of discontinuous distribution: Cussonia umbellifera, apart from its occurrence at Wit Els Bosch, Zitzikamma, is not known to grow west of the St. John's River; in the Zitzikamma it is confined to several forest patches in close proximity to each other. In these forests it is abundant and vigorous. Faurea McNaughtonii is known from

* Recorded Flora Capensis III, 18, not collected.
† Since collected by General Smuts in mountains of Stellenbosch district.
‡ Since recorded from Nkandhla, Zululand.

several localities in the Transkei, and from one in Natal; it occurs in profusion in the Gouna Forest Reserve, Knysna, but is confined to one small forest; it is vigorous and fast-growing. Pygeum africanum is known from the Kaffrarian Forests, but does not occur in those in the Alexandria district; it occurs in one spot (about twenty trees only) at Blaauwkrantz, Zitzikamma. Trichocladus ellipticus, a common shrub of the eastern forests, occurs in several spots in the Knysna Forests, being represented by a few individuals only. Psychotria capensis, a common shrub of the eastern forests, is absent at Alexandria, and reappears in one spot in the Knysna region only—in the "Lilyvlei" Forest, Gouna.

From the foregoing it is seen that, of the 300 to 325 plants common to the forests of Natal and the Transkei (60 confined to Natal and the Transkei, plus 130 common to Natal, the Transkei, and the eastern forests, plus 130 common to Natal, Transkei, eastern forests, and the Knysna), about 250 to 255 only occur when the range is extended to the eastern Cape Province Forests—i.e., some 60 species drop out as the west is approached. It is further clear that, as the wide-ranging species at the Knysna number about 130 (excluding 25 that are practically endemics), approximately 180 to 185 species common to Natal and the Transkei drop out in the Knysna region—i.e., about 125 species in addition to the 60 or so which dropped out in the eastern Cape Province.

Bews (1925) rightly has pointed out the significance of this decrease, with respect to the origin and history of the subtropical species. He puts forward the highly suggestive hypothesis that the subtropical species of trees and shrubs are directly or indirectly derived from allied tropical forms in the great primitive forests of eastern and central Africa.

As Bews (1921) has suggested, from tropical species may be derived more temperate species, while these again, in their wanderings, on meeting new climatic, edaphic, or biotic conditions, may produce forms that are either more mesophytic or more xerophytic. The tree and shrub flora at the Knysna, as elsewhere in South Africa, is a derivative one, composed of subtropical species. Apart from considering these to have originated from tropical African forms, no feasible phylogenetic or geographic origin for these can be suggested. Climatic and topographic factors must have played, and must still be playing, considerable part in determining which species might proceed south and west, and how far such species might migrate in these directions. Owing to the barrier imposed by the great Kalihari, high veld, and Karroo regions to the north, and the extensive Namaqualand and Namib regions on the west, the invasion by the tropical-subtropical species could not have been directly south or southwest. The mountain barrier formed by the Drakensberg, Stormberg, Sneeuwberg, Nieuwveldt, and minor Cape ranges, and the coast-line itself, must have formed the indirect lines of invasion from the north and east.

Now, two factors may account for the comparative paucity of subtropical forms at the Knysna, at Swellendam, and in the Cape Peninsula. Firstly, the climate may have been unfavourable to those species requiring higher temperatures, experiencing different rainy seasons, and in some instances a lower annual rainfall; the poor acid soils, often in possession of macchia, may have proved uncongenial; still-undetected biotic factors may have assisted in precluding the establishment of others.

Secondly, we have to take into account those weighty factors, *distance and time*. Without subscribing to the Willis theory of "Age and Area" (Willis, 1922) to any more than a very slight degree, it seems evident that these factors may provide a part explanation of the poverty of the subtropical flora of the Knysna region. Assuming the source of the forms to have been in the Tropical Central and East African Forests, there can be little doubt that it must have taken the first-derived species considerably less time to reach the Transkeian and Eastern Forests than it did to enter those of the Knysna, while they would have been in position in the latter region long ere they had made their appearance at Swellendam and the Cape Peninsula. For lack of the necessary perspective, we are unable to say whether or not in the ages to come species as yet limited to the Natal, Transkei, and Eastern Cape Province Forests may not appear in the Knysna. Migration along the mountain tops and slopes and along the coast-line must be taking place to-day as surely as was the case in Cretaceous and post-Cretaceous times.

It is felt that both hypotheses contain portions of the truth ; modifications robably have been brought about by other, and less important, agencies.

The occurrence of endemic forms at the Knysna does not, in the opinion of the writer, detract from the possibility of these suppositions containing in them portions of the truth, for the endemics may be looked upon as being derived from derivative subtropical species on the occasion of the latter experiencing some new set of conditions, climatic, edaphic, or biotic. Discontinuity in distribution is exhibited by the species listed under paragraph 6 above, and is accountable on the supposition of *polygenesis* having taken place : the same or an allied species forming in diverse localities the sources from which the new species originated.

Vide Appendix IV.—Brief summary of Floristic data.

Chapter VII.

CONSTITUTION and STRUCTURE of the HIGH FORESTS.

Chapter VII.

CONSTITUTION AND STRUCTURE OF THE HIGH FORESTS.

General.

The Knysna Forests, in common with most other South African Forests, are of a decidedly mixed nature. Unlike most European and North American, and certain Asiatic and Australian Forests, they show few pure communities so far as the dominant species are concerned—instead there is a general mixing of species. Occasional pure communities do, of course, occur, but these are of comparatively small extent. The most important species—Olea laurifolia, Podocarpus Thunbergii Hook., P. elongata L'Herit, Ocotea bullata, and Apodytes dimidiata—are large trees playing the parts of dominants and major subdominants throughout the greater portion of the Forests. Olea laurifolia and Podocarpus Thunbergii Hook.—as is seen from the frequency data given in Table XXXIII, p. 206—are the most abundant of the large trees. They are the most important of the dominants, and react more upon the factors of the habitat than do any of the other large trees covering the same area. P. Thunbergii Hook. when dense reacts strongly upon the soil moisture, the ground round the roots being often very dry to a depth of 18 inches, during periods of relative drought. Olea laurifolia, the most shallow-rooted tree in the Forests, too draws strongly upon the soil moisture but has a second and more important reaction—that of reducing to an appreciable extent, the light-intensity. Its crown is large, its foliage abundant, persisting over long periods, and of a dark olive green. There is little doubt that although other large trees rear their heads up to the level of the crowns of the two species under discussion, they are secondary in their reactions within the community. At all events their younger regeneration stages, in the climax communities, are to a large extent controlled by the two major dominants. The regeneration stages of these major dominants are able to tolerate excessive shade for very long periods without exhibiting inhibited growth or without dying, although they do, of course, grow faster and better when they are provided with better illumination.

Olea laurifolia and Podocarpus Thunbergii Hook. are usually more abundant on the warmer and drier aspects, and these are almost invariably the sites that carry luxuriant and extensive layer societies of Trichocladus crinitus, from 8 to 15 feet high. This layer society has been found to react both upon the soil moisture and upon the light-intensity—reducing both appreciably. The regeneration of species other than Olea laurifolia and Podocarpus Thunbergii Hook. that might readily flourish under cover of these major dominants, has to contend with this important layer society.

Trichocladus layers do occur in Forest where Olea and Podocarpus Thunbergii Hook. are not abundant, but are not usually so well developed in such localities.

There are two important biotic associates that tend to regulate the reactions of the two major dominants, and which probably prevent them from ultimately forming communities from which most or all of the other large tree species would be absent. The first of these is the fungus *Fomes applanatus Gill*, a wide-spread parasite of the boles of

Olea laurifolia, producing conditions of decay and ultimately death. Severely attacked trees, in addition, are frequently blown during strong winds. The second is the *Ascolichen Usnea barbata Fries*, the fungal component of which enters the outer tissues of the bark of the twigs and branches of Podocarpus Thunbergii Hook., and brings about gradual drying out and death of the crowns. Much of the foliage is enveloped in the waving " beard " of the organism, and thus is prevented from assimilating normally. P. elongata L'Herit, and Apodytes dimidiata occassionally show the evil influences of this organism [*vide* Phillips, 1929; for details of the ecology of Usnea and the supporting tree].

The Principal Seral and Climax Communities in High Forest.

1. *The Principal Priseral Communities.*

(a) Consocies.

The only consocies of any importance that are to be distinguished are described below. Most of these communities are of small extent, and mingle at the margins with one another, or with certain of the associes, consociations and associations described in this Chapter.

A consocies may be defined as a seral community characterized by a single dominant.

1. *The Virgilia capensis consocies.*

This important community has been described by Phillips (1926: 3) elsewhere. It is represented in hydroseral, lithoseral, and psammoseral successions, but most often develops in the first-named.

Development of the community takes place with Macchia as the origin, and from the community may develop several different associes in which Virgilia is one of the dominants.

Virgilia invades the Macchia, grows faster than the Macchia dominants, and within a year or two shades the latter to such an extent that gradual decrease in luxuriance is the result. The invader gradually increases in number and in size, and finally subjugates the few Macchia plants that remain on the ground.

The consocies is usually well-stocked—as many as 2,000-3,000 stems, 30 feet high and 6-18 inches girth at $4\frac{1}{4}$ feet from the ground, are to be found per acre. The stems are usually upright and clean, and the crowns reduced but well balanced. The floor does not show the presence of regeneration of the dominant, but usually that of other Forest tree species, notably Halleria lucida, Burchellia capensis, Plectronia Mundtii, Celastrus acuminatus, and Myrsine melanophleos.

2. *The Osteospermum moniliferum consocies.*

This consocies is best represented in coastal Forest and in some montane Forests. It is an early stage of the Forest sere proper, and develops to maturity within 5-10 years. The heavily-branched stems attain an average maximum height of 15-20 feet, and an average maximum girth of 6-9 inches. The canopy of the large shrubs form is well knit. The ground is usually clear of rank vegetation owing to the strong reaction upon the light. The consocies does not regenerate itself unless the older shrubs are removed and the soil is exposed to the sun. In time the community thins out owing to the death of some of its members, and seedlings of Halleria, Burchellia, Royena lucida, R. pallens, R. glabra, Celastrus buxifolius, Rhamnus prinoides, Plectronia spp, establish themselves, finally developing to such a height that they convert the Osteospermum consocies into a mixed associes of small trees and shrubs.

3. *The Spermannia africana consocies.*

The priseral Sparmannia consocies is characteristic of the beds and sides of moist ravines near the upper limits of Forest lying on the mountain slopes, and of moist depressions within the Forests, not as yet held by taller growing communities. The consocies grows to an average maximum height of 15 feet, the canopy formed being well knit, but allowing entrance to a large percentage of the light. The ground usually bears socies and societies of Hydrocotyle asiatica and spp., Ranunculus pinnatus, Impatiens capensis, Plectranthus fruticosus and Cyperaceae. Normally, regeneration of the dominant is sparse, despite the production of an abundance of seed; on being disturbed, the soil produces an abundance of tiny seedlings most of which succumb. The species coppices abundantly.

The consocies is ultimately invaded by Halleria lucida, Rhamnus, Polygala myrtifolia, Celastrus acuminatus, Royena lucida, and Plectronia spp., the Halleria usually being the most abundant.

The consocies is finally converted into the *Halleria—other spp. associes.*

4. *The Halleria lucida consocies.*

This community, in its priseral state, is best represented in the moister Forests at higher elevations. It is seldom extensive in any one spot, but on the aggregate, covers a large area. The dominant attains an average maximum height of 15-25 feet, with boles of 12-24 inches at 4¼ feet above ground. The tree is rarely upright, usually growing at angles. The canopy is well knit, but allows entry of a large proportion of light—from 1/5 to 1/30 of the total available exterior to the crowns. Occurring in the community as subdominants are Rhamnus, Polygala myrtifolia, Celastrus acuminatus, Royena lucida, the shrubby Osteospermum moniliferum and Cluytia pulchella. The usual procedure is for the consocies to develop into either the *Halleria—and other spp. associes* or into a general mixed associes.

5. *The Brachylaena neriifolia consocies.*

Consocies of this species are widely spread along all watercourses, in the beds of ravines, in moist depressions, and along the moist S. and S.E. faces of the mountains at elevations below 3,500 feet. The large woody, shrubby dominant forms almost impenetrable communities; where it is well developed no other species are found in association with it, nor as subdominants within its borders. Along its margins, however, dense societies of Todea barbara, Blechnum capense and other ferns thrive. The reaction upon the light is very marked. On the death of members of the consocies, invasion by Sparmannia, Halleria, Osteospermum, Burchellia, Plectronia Mundtii, takes place, while the fern societies increase in size and in general luxuriance, the result being the development of the *Brachylaena neriifolia—other spp. associes.* Brachylaena does not regenerate itself in the consocies.

6. *The Sideroxylon inerme consocies.*

This is almost entirely confined to the Littoral Forests; a few examples, however, do occur in montane Forest of short nature.

The stout-stemmed, strongly branched, heavily foliaged dominant attains in such communities an average maximum height of 25-30 feet, the girth at $4\frac{1}{4}$ feet above ground being between 2 and 4 feet.

The boles, however, rarely stand upright, but are inclined at various angles. The canopy is dense, the reaction upon the light being strong. At the coast little ground vegetation occurs beyond occasional societies of Knowltonia spp., Hypoestes aristata, and Aspidium capense, and scattered plants of Haemanthus puniceus.

The species does not regenerate at this stage, although rich fruit crops are borne.

The consocies must hold the ground for very lengthy periods, no change taking place, it is estimated, for at least a century, unless a number of the members be wind-blown.

7. *The Ekebergia capensis consocies.*

The Ekebergia consocies is entirely coastal, usually occurring quite near the zone of Littoral Bush. There is no extensive development of this community, and those consocies that do occur are small.

The general height of the community is from 25-35 feet, the boles ranging from 2 to 4 feet in girth at breast-height. The canopy is well knit, but allows entry to a good deal of light, more especially at seasons when the species is more or less deciduous.

Subdominants within the consocies are Plectronia ventosa, Celastrus buxifolius, C. acuminatus, Elaeodendron Kraussianum, Cassine scandens, Euclea macrophylla, and other small trees and shrubs. Knowltonia spp., and Hypoestes aristata may form dense ground societies.

The dominant regenerates fairly well, provided the ground societies are not too dense.

A mixed associes appears to succeed the consocies, which, however, seems to hold the ground for lengthy periods [*vide* Phillips, 1927 : (4)].

8. *The Myrsine melanophleos consocies.*

This community occurs throughout the Forest range, but shows its best development near the coast. While the individual communities are small, the total area covered by them is large.

The canopy is well formed, the average height being from 35-45 feet, the boles attaining girths at breast-height of 2-4 feet.

Subdominants are often numerous, being principally Elaeodendron spp., Celastrus spp., Halleria lucida, Burchellia capensis, and Trichocladus.

The dominant regenerates freely, but few of the millions of first-stage seedlings ever attain sapling size, owing to biotic enemies and to the strong reaction upon the light.

The consocies may develop from the *Virgilia—Myrsine associes* the light-demanding Virgilia being ousted gradually by the shade-casting Myrsine. The consocies seems to develop into a very mixed associes in which Olinia cymosa and Pterocelastrus are fairly abundant, or into the *Olinia—Myrsine associes.*

9. *The Olinia cymosa consocies.*

Biological features of interest have been described for the species by Phillips [1926 : : (1)].

The community is well developed throughout the Forest range, but is particularly fine upon some of the drier ridges of the Uplands plateau.

The canopy is dense, the height of the consocies ranging from 35-45 feet, the girths lying between 3 and 5 feet. The boles are well shaped and the crowns symmetrical.

Subdominants are Pterocelastrus, Celastrus peduncularis, C. acuminatus, Elaeodendron croceum, Burchellia, and sometimes Myrsine and Ekebergia. The ground societies are Blechnum punctulatum, B. australe, Aspidium capense, and Schoenoxiphium lanceum.

Regeneration is usually very rare, seed beds being far scattered.

The consocies either develops into the *Olinia—Pterocelastrus associes* or into a more mixed community of various spp. none of which are definitely dominant. Occasionally development may be in the direction of the *Olinia-Myrsine associes*. The *Virgilia capensis consocies* is often the origin of this community.

10. *The Pterocelastrus variabilis consocies.*

This distinctly variable species consisting of at least 3 well-marked forms, develops important consocies throughout the Forest range. The best communities, however, are to be found on the drier ridges and on the warmer aspects of the Uplands plateaux. The stocking is dense, the canopy close, the reaction upon the light moderately strong. The average height is from 30-40 feet, the girths at breast-height ranging from 2 to 4 feet. The species exhibits plank buttresses, otherwise the boles are symmetrical.

Associated subdominants are Olinia cymosa, Celastrus spp., Elaeodendron croceum, E. capense, Royena pallens, R. lucida, Lachnostylis capensis, and Plectronia obovata. In course of time, these species, particularly the Celastraceous forms, increase in importance and convert the consocies into the mixed *Celastraceae—other spp. associes.*

Frequent ground species are Blechnum punctulatum, Moraea iridioides, Gerbera cordata, and Schoenoxiphium lanceum.

11. *The Podocarpus elongata L'Herit. consocies.*

The Podocarpus elongata consocies, the Podocarpus consociation (vide p. 180 this Chapter), and the *Podocarpus consocies developing to form the Podocarpus elongata-other spp. association* (*vide* p. 181 this Chapter) are to be distinguished with care.

The *Podocarpus elongata consocies* to-day is fairly well represented near the coast and along river valleys inland, only.

The consocies originally consists of a fairly pure stand of young P. elongata; these in the course of four or five centuries attain maturity,*[1] their dimensions being considerable: 120-140 feet full height, with boles 8-20 feet girth at breast-height. If the community be extensive and does not open up its canopy it remains climax—the *Podocarpus elongata consociation*. As a rule, however, the canopy is not sufficiently dense to preclude the establishment and growth of such spp. as Podocarpus Thunbergii Hook., Olea laurifolia, Apodytes, and Ocotea, and the consocies is gradually converted into a climax community—a mixed association in which P. elongata is one of the major dominants. In other words, the term *Podocarpus consocies* is

*[1] Based upon their mean annual increment.

to be applied to a stand of the species either in its immature state, or in its mature state if its opened canopy encourages the establishment and growth of species such as those listed above.

Such a consocies developing to form an association is well exemplified by the beautiful Podocarpus elongata Forest on the Groot River (*vide* Map), Knysna division. A brief description of this community follows:—

The Podocarpus elongata are hoary giants ranging from 5-23 feet in girth, and in full height from 80-120 feet, with huge, outspread limbs themselves many feet in length and several feet in girth. The boles and lower crowns are densely draped with tangles of Senecio angulatus, S. mikanioides, S. quinquelobus, Mikania capensis, Scutia indica, Sarcostemma viminale, Cynanchum obtusifolium, Secamone Alpini, and species of Cissampelos, and Zehneria, and the dark green Pyrenacantha scandens. Not infrequently the parasitic Ficus Burtt-Davyi casts its strangling coils round the trees.

The epiphytic Polypodium spp., Elaphoglossum conforme, Lycopodium gnidioides, Angraecum, Polystachya, and Mystacidium, and Peperomia relexa are common upon the giant branches.

The number of boles of the dominant per acre varies from 1 to 10, the intervening areas bearing occasional P. Thunbergii Hook., Olea laurifolia, O. capensis, O. foveolata, Apodytes, Ocotea, Calodendron, Toddalia, Kiggelaria, Celtis, Pterocelastrus, Elaeodendron. Kraussianum, E. croceum, Sideroxylon, of small size, and dense thickets of still smaller trees and shrubs, principally composed by Olea capensis, Trimeria, Euclea macrophylla, E. racemosa, Royena pallens, Celastrus buxifolius, Cassine scandens, and Trichocladus. The ground societies are of Plectranthus, Hypoestes verticillata, H. aristata, Knowltonia glabricarpellata. Stelitzia augusta occurs occasionally, sometimes over 30 feet in height.

The frequency of P. elongata, according to number of stems over 3 inches in girth at breast-height, is approximately 18% a high figure when it is remembered that very few young plants of the species occur.

12. *The Platylophus trifoliatus consocies.*

This community has been described by Phillips [1925: (1): 147-148] elsewhere.

It is essentially a hydroseral community arising during the occupation of the ground by the hygrophilous small tree and shrub stages (e.g. the *Brachylaena neriifolia-other spp, associes.*) It is best developed along moist valleys and in moist depressions on the plateaux, and in moist montane ravines. The communities are rarely extensive, usually being much longer than they are broad, their width seldom exceeding 50 yards. There are rarely more than 25 trees to the acre, as the boles (ranging from several to over 20 feet in girth at breast-height) lean at various angles, and as the crowns are much spread. The general height of the canopy is 40-50 feet. The reaction upon the light is excessive, and for this reason regeneration of seedling and sapling stages is sparse.

There are well developed Hemitelia capensis and Marattia fraxinea layers, while the boughs and boles bear rich epiphytic societies of Lichens, Mosses, Lycopodium gnidioides, Polypodium ensiforme, Polypodium lanceolatum, Elaphoglossum conforme, Hymenophyllaceae, Vittaria, Polystachya, Angraecum and Mystacidium.

From all appearances, the consocies remains on the ground many centuries, and in some instances seems to be of the nature of a subclimax community. In the normal succession the consocies develops into the *Platylophus-Cunonia associes* through the invasion of opener, better illuminated portions by Cunonia capensis.

13. *The Cunonia capensis consocies.*

In moist montane ravines and on the moist, cool slopes of the upper foothills this community is well represented. It rarely occurs on the plateaux, and is absent from the littoral.

The general height of the canopy varies from 10 feet to over 50 feet according to habitat, the controlling factors being holard, soil depth, and protection from wind. The stunted type generally is found on the more exposed, shallow-soiled portions of the higher altitudes, the better type on the secluded, deep-soiled sides of valleys.

The density of stocking is high, there being often as many as 50-70 boles (ranging from several feet to over 6 feet in girth at breast-height) to the acre, besides numerous saplings and poles. The younger stage regeneration is scanty (except for a few weeks after the fall of the millions of minute, winged, and delicate seeds) the reason for this poverty being the strong reaction of the trees and the associated Hemitelia, Todea barbara, Marattia and Plectranthus fruticosus layers upon the light. In addition, the soil is exceedingly moist, is cold and shows high acidity.

The communities on the more extreme, exposed sites seem to be of subclimax nature, but those on the better sites develop into mixed associations of moist type.

14. *The Tarchonanthus camphoratus consocies.*

Tarchonanthus camphoratus forms small consocies in Littoral Forest, and along the margins of drier type, isolated, inland Forest.

The boles are usually much inclined and the boughs are heavy and widespread. Below the dominant are fairly close layers of shrubs, the principal being Euclea spp., Celastrus buxifolius, C. nemorosus, Rhamnus prinoides, and Carissa arduina. The height of the dominant rarely exceeds 25 feet, while the girths range from 1½ to 2½ feet at breast-height.

The community ultimately develops into the *Elaeodendron Kraussianum-other spp. associes* on the coast, and inland, into the *Celastraceae-other spp. associes.*

(*b*) *Associes.*

The associes of most general occurrence are described below. Like the consocies these communities are seldom of any extent; they merge one into the other at times, and at others mingle on their margins with the consocies already described.

An associes may be defined as a seral community characterized by two or more dominants.

1. *The Virgilia—Myrsine melanophleos associes.*

This associes arises from the *Virgilia consocies* in the event of there being present much larger numbers of seedlings and saplings of Myrsine than of other Forest species (e.g. Halleria, Burchellia, Plectronia Mundtii, Pterocelastrus, Olinia.) The regeneration of Myrsine develops rapidly under the congenial light and moisture conditions available, and within 20-30 years is capable of sharing the dominance with Virgilia. The usual procedure is for the development of Myrsine—in size and in number—to proceed to such an extent that the Virgilia itself is ultimately dominated and ousted, the *Myrsine consocies* being the result.

The *Virgilia-Myrsine associes* attains an average maximum height of 30-45 feet, the boles ranging from 1-2½ feet in girth in the instance of Virgilia, and from 1½-4 feet in that of Myrsine.

Regeneration of Myrsine is abundant, and much of it develops until such time as the Myrsine itself reacts too strongly on the light.

2. *The Virgilia—and—other species associes.*

This mixed associes is the result of there being a fair representation of the seedlings and saplings of such Forest species as Halleria, Burchellia, Plectronia Mundtii, P. obovata, Royena lucida, Celastrus spp., Pterocelastrus, Olinia, Olea capensis, O. foveolata and Nuxia floribunda, present, and possibly a few plants of Myrsine, Podocarpus spp., Ocotea, Apodytes, and other of the larger and more valuable Forest trees.

The tendency is for the species listed to assume a co-dominance with Virgilia, and for them to subjugate and finally oust this plant. For a time, however, there is a fairly well balanced co-dominance, the usual co-dominants being Virgilia, Halleria, Royena, Celastrus acuminatus and Pterocelastrus. Regeneration of Virgilia does not appear,* but that of the other species is usually abundant, while that of the larger tree species is also represented.

The community is an important one, ushering in as it does, the advance stages of the climax Forest.

3. *The Brachylaena neriifolia—other species associes.*

As already described (*vide* p. 171 this Chapter) this community develops from the Brachylaena neriifolia consocies. It may also arise direct from Hygrophilous Macchia. It is a very mixed associes consisting principally, it is true, of B. neriifolia, but showing in addition various partial co-dominants: Halleria, Burchellia, Plectronia Mundtii, Osteospermum moniliferum, Rhamnus prinoides, and Sparmannia africana. There is an abundance of Todea barbara, Blechnum capense, Marattia fraxinea, and in opener sites, of Pteridium aquilinum. Saplings of Platylophus trifoliatus occasionally are to be found, for it is in this community that the Platylophus communities (vide pp. 192-193 and 198-199 this Chapter) have their origin. The canopy is rarely higher than 20-25 feet, and the stocking is dense in places but exceedingly sparse in others.

Despite the small size of the co-dominants, lianes and epiphytes are not uncommon, the general luxuriance of the vegetation being doubtless due to the high humidity of the habitat—which is usually in moist, cool valleys and depressions.

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* Owing to the seeds (which are abundant) receiving no stimulus to germinate; the few plants that do appear are not able to develop owing to the low light intensity.

4. *The Halleria—other species associes.*

Halleria lucida, Burchellia, Royena lucida, Gonioma Kamassi, are the usual co-dominants. Associated as subdominants are seedlings and saplings and poles of Podocarpus Thunbergii Hook., Olea laurifolia, Apodytes, Ocotea, and Curtisia faginea.

The associes is of wide occurrence, and of considerable importance. It is a frequent subseral community on the sites of exploitation and fire.

The canopy is well knit but not dense, excellent conditions of illumination being provided for the saplings and seedlings below. The average height is from 25-35 feet.

5. *The Elaeodendron Kraussianum—other species associes.*

The community is developed in Littoral Forest and on drier, more coastal portions of the Uplands plateau. On the plateau, shallow-soiled ridges experiencing N. and N.W. aspects usually show the best communities.

Elaeodendron Kraussianum assumes an average maximum height of 25-30 feet and a girth of 2-2½ feet at breast-height. Its saffron-hued boles are rarely upright, but are generally inclined, and carry asymmetrically-placed crowns. Usually associated with this tree as co-dominants, are Pterocelastrus variabilis, Ochna arborea, Sideroxylon inerme, Lachnostylis capensis, Royena lucida, R. pallens, Plectronia obovata, Plectronia ventosa, and sometimes stunted Podocarpus elongata L'Herit. Subdominant species of importance are Euclea macrophylla, Trichocladus, Celastrus buxifolius, Ochna atropurpurea (shrub). The stocking is fairly dense, the canopy well knit, the reaction on the light strong. Scutia and Secamone Alpini are common lianes; ground communities are constituted by Blechnum punctulatum, B. australe, Moraea iridioides, Tetraria sp. nov.*

Regeneration of E. Kraussinaum is sparse, but that of Pterocelastrus and Royena lucida is more abundant, while that of P. elongata L'Herit may be locally abundant.

The origin of the community is identical with that of the Celastraceae-other species associes described below; it develops from the Tarchonanthus consocies. The associes appears to develop into the *Celastraceae-other species associes* which is of higher successional rank.

6. *The Celastraceae—other species associes.*

This community principally originates through the increase in Celastraceae in an associes of the type above described: Pterocelastrus increases in number, while Celastrus acuminatus, C. peduncularis, Eloeodendron croceum, E. capense appear, and play important parts. E. Kraussianum, may, but generally does not, remain as a co-dominant or even as a sub-dominant.

Associated with the Celastraceae as co-dominants are some of the same species as occurred in the *Elaeodendron Kraussianum-other species associes*: Plectronia obovata, Ochna arborea, Royena lucida, Olinia cymosa, Gonioma Kamassi may occur fairly abundantly.

Species of lesser importance are Lachnostylis, Royena pallens, Plectronia Mundtii, Burchellia. The ground vegetation is much the same as in the *Elaeodendron Kraussianum-other species associes.*

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* According to Dr. Schönland.

7. *The Pterocelastrus—Lachnostylis associes.*

Forests on Bokkeveld show the above community, more especially on drier ridges and on shallow-soiled slopes of N. aspect. In this community Pterocelastrus variabilis is a stunted tree of pole size only: 20-30 feet high with a girth ranging from 12-24 inches at breast-height. It occurs abundantly. The other dominant, Lachnostylis capensis, assumes fairly large dimensions when associated in this manner—short boles of 1½-2 feet girth are not uncommon, while the average maximum height is about 30 feet.

Mingled with the dominants are poorly-grown individuals of various species, especially Olea capensis, O. foveolata, O. laurifolia, Plectronia obovata, Ochna arborea, Gonioma Kamassi, while Trichocladus crinitus forms fairly dense layers. Tetraria sp. nov. and Gerbera cordata form the ground vegetation. Regeneration of all tree species mentioned is scanty.

The associes appears to remain subclimax for very long periods, but under favourable conditions (supplies of seed, opening up of the canopy of the consocies, increase in moisture content of the soil) develops into the *Celastraceae-other species associes* above described.

8. *The Olinia—Myrsine melanophleos associes.*

In its purest form this community is not frequently met. It is to be found along certain Forest margins on the Uplands plateau.

The *Olinia cymosa consocies*, or the *Myrsine consocies* is its origin, and it appears to develop into the *Olinia-Pterocelastrus-other spp. associes*, in time.

The dominants have associated with them as subdominants such species as Olea laurifolia, Podocarpus Thunbergii Hook., and Apodytes in a stunted form. The general height of the dominants ranges from 30 to 40 feet, with the girths ranging from 3 to 5 feet.

9. *The Olinia—Pterocelastrus—other species associes.*

The *Olinia cymosa consocies* contains Pterocelastrus as a subdominant, and it in instances happens that this species is able to assume the importance of a dominant. There are associated with the dominants various subdominants: small trees of Olea laurifolia, Podocarpus Thunbergii Hook., Apodytes, Ocotea, Curtisia, and sometimes Elaeodendron croceum and medium-sized Myrsine.

The boles of the dominants are upright and the crowns symmetrical.

The average height is from 35-45 feet, the girths ranging from 2½-3 feet in the instance of Pterocelastrus and up to 5 feet in that of Olinia. The canopy is dense, the reaction upon the light strong. Regeneration of Olea laurifolia and Podocarpus Thunbergii Hook. is fairly well represented, that of Olinia being almost entirely absent, that of Pterocelastrus sparse.

On uncongenial sites the associes may remain in a subclimax state, but where the edaphic and biotic factors are favourable, the development is in the direction of mixed Forest of medium holard.

10. *The Platylophus—Cunonia associes.*

This community has been described by Phillips [1925 (1): 148-149] elsewhere. It develops from the *Platylophus consocies* (*vide* p. 174 this Chapter). In turn it is invaded by Ilex mitis, Nuxia floribunda, Ocotea bullata, Apodytes, Podocarpus Thunbergii Hook., and Olea laurifolia, which duly assume dominance, converting the associes into a mixed climax association of moist type.

The average number of boles per acre in the associes is higher than in the *Platylophus consocies*, owing to the Cunonia capensis being more upright and less umbrageous than Platylophus.

The canopy is closed, but not as dense as that in the *Platylophus consocies*, as the crowns of the Cunonia are, on the whole, at a higher level than those of the Platylophus.

Regeneration of Platylophus is sparse, that of Cunonia more frequent. Seedlings of Ilex, Apodytes, Ocotea, Podocarpus spp., and Olea laurifolia occur. Hemitelia, Blechnum capense, and Plecthanthus fruticosus form close layers. The soil is moist, cold and acid but in lesser degrees than in tho *Platylophus consocies*.

11. *The Podocarpus elongata L'Herit—other species associes.*

This community is really a transition stage between the *Podocarpus elongata L'Herit. consocies* (*vide* p. 173 this Chapter), and the *Podocarpus elongata L'Herit—other species association* (vide p. 181 this Chapter). The account of the Groot River Podocarpus elongata L'Herit. Forest sufficiently describes the nature of this transitional stage.

12. *The Cussonia umbellifera—other species associes.*

Cussonia umbellifera, apart from its occurrence in several Forests (Kwaaibrand, Koomansbosch) on the Witte Els Bosch Forest Reserve, is not found west of St. John's River mouth. In the Forests mentioned, there are abundant trees of the species, occurring in places in very small consocies, but more generally found in association with Podocarpus Thunbergii Hook. Olea laurifolia, Apodytes, and Celastraceae. Adult trees of Cussonia are from 40-50 feet in height, with girths ranging from 2½-5 feet. They are umbrageous.

The origin of the communities and their developmental nature are alike unknown, but it seems likely that they are of seral nature, hence their inclusion here.

13. *Mixed associes.*

In addition to the twelve associes above described, there are various modifications of these, so numerous and so indistinctly separated, that it would serve no useful purpose to list and to describe them. The mixed associes, in common with those already described, are precursors of the mixed associations of the climax Forest.

Subseral communities are discussed in Chapter 10.

(2) The Principal Climax Communities.

(*a*) *Consociations.*

The consociation may be defined as a climax community characterized by a single dominant.—This type of community is not well represented in the Forests of the Knysna, nor indeed in any other South African Forests. The sole moderately extensive consociation is that of Podocarpus elongata L'Herit. Ocotea bullata in montane ravines sometimes shows fragmentary consociations, while Olea laurifolia and Podocarpus Thunbergii Hook. very occasionally occur in very local pure communities. Indeed, one of the features that strikes the European botanist most forcibly in examining the Knysa Forests is the marked absence of pure dominance of any extent. The reason for this absence is by no means clear; it is a general feature of tropical and sub-tropical woodland, and possibly is linked up with the phylogenetic history of the component species.

The few consociations requiring mention are described below.

1. *The Podocarpus elongata L'Herit, consociation.*

This community is a feature of the level ground within stream and river bows throughout the Forest range; it is also represented in ordinary climax Forest, but to a lesser extent. It is distinct from the *Podocarpus elongata L'Herit consocies* (*vide* p. 173, this Chapter) in that it shows no tendency to change the pure dominance for a partial or mixed dominance. The giant trees rear their canopy 80-120 feet above the ground, this canopy being well knit and reacting fairly strongly upon the light. Layer societies of Hemitelia (moister sites) or of Trichocladus crinitus (drier sites) occur at the bases of the giant trees.

2. *The Olea laurifolia consociation.*

This community is always of local extent, and is always associated regionally with the *Podocarpus Thunbergii—Olea laurifolia—other species association.* Pure dominance of Olea laurifolia, however, does occur on small areas. The density of the heavily foliaged, extensively developed crowns is very great, the reaction upon the light being excessive. The trees are usually symmetrical, upright, and of full height 50-70 feet, their girths at breast-height being between 4 and 8 feet. Despite the weight of the crown and the size of the heavy bole, the roots are extremely shallow, the reaction upon the holard of the upper 6 to 18 inches of soil is therefore very great. Regeneration of the species occurs in great profusion a year or more after a fall of fruits (*vide Appendix I*, under the species), but fungus diseases account for the overwhelming majority of the young plants. The Trichocladus crinitus layer society is exceptionally well developed in this community.

(*b*) *Associations.*

The association may be defined as a climax community characterized by two or more dominants.

Strange as the statement may seem, it is nevertheless true that this community is the best represented unit of vegetation in the Knysna Forests. At the same time, distinctly demarcated examples are by no means abundant, the reason for this being the innumerable variations in specific stocking shown by the climax Forests. One association merges with another, a third invades the margins of the second, and is itself to greater or less degree intermingled with the members of the tension zone of a fourth—and so on. *The climax Forest as seen to-day is in reality nothing but a synthesis or complex of a large number of associations*, except where seral communities exist and where local consociations and well-defined associations occur.

The degree of mixing of trees large and small in typical climax Forest is well set forth by the percentage frequency data shown in *Table XXXIII*, p. 183, and by the figures in *Tables XXXIV-V-VI* (pp. 184-186) for 2-acre portions of Forest on the Kaffirkop, Deepwalls, and Gouna Reserves.

The few associations that are fairly distinct are described below.

1. *The Podocarpus elongata L'Herit—other species association.*

This community consists of an upper story (80 to 130 feet high) of Podocarpus elongata L'Herit, the crowns of which in some instances almost touch, overlap in others, and are well separated in yet others. The second story usually is constituted by the taller individuals of Podocarpus Thunbergii Hook (70 to 90 feet high), the third story by numerous Olea laurifolia and by a scattering of Ocotea, Apodytes, Myrsine, Ilex, taller Pterocelastrus, and taller Curtisia; the fourth story is made up by Nuxia, Elaeodendron croceum, Plectronia obovata, and others; Hemitelia or Trichocladus form the layer societies.

The association has much in common with the *Podocarpus Thunbergii—Olea laurifolia—other species association* described below, the only difference of importance being that in the last-named association, Podocarpus elongata L'Herit, is either far less abundant or else is quite absent, and that large Podocarpus Thunbergii Hook. and Olea laurifolia are more numerous than they are in the association being described.

From a study of portions of undistributed climax Forest in various localities (e.g. at Deepwalls, Sourflats, Millwood, Gouna, Kaffirkop, Harkerville) it seems that the *Podocarpus elongata—other species association*—must have been more common before the exploitation of Forest commenced. Podocarpus elongata L'Herit. was exploited from the times of the first appearance of the European. In 1876 it was found that the larger individuals of this species, on account of their cumbersome nature, were being rejected by woodcutters, so in order to encourage the removal of such trees, 25 per cent. gratuity was granted on the licence-value of each such big tree. To this practice is due to some extent the paucity of Podocarpus elongata L'Herit. in some parts of the Forest, and its complete absence from others. At the same time it is evident that from large portions of Forest Podocarpus elongata L'Herit. has been absent many centuries, possibly through natural elimination in the development process.

As has already been described (*vide* pp. 173 and 174, this Chapter), the *Podocarpus elongata L'Herit.—other species association* develops from the *Podocarpus elongata L'Herit. consocies.* It seems that in some instances, at all events, decay of the giant dominant results in the elimination of that species from the community, as a dominant, either for very many centuries, or for all time.

2. *The Podocarpus Thunbergii Hook.—Olea laurifolia—other species association.*

The above association is a decidedly mixed one, but shows as major dominants, P. Thunbergii Hook. and Olea laurifolia. The importance of the reactions of these species has been described already (*vide* p. 169, this Chapter).

Associated with the two dominants proper are large trees of Apodytes, Ocotea, Ilex (moist sites only), Pterocelastrus, smaller trees such as Curtisia, Elaeodendron croceum, Celastrus spp., Plectronia obovata, Ochna arborea, Nuxia, Gonioma, Olea capensis, Lachnostylis, Halleria, and Kiggelaria. Podocarpus elongata L'Herit. occurs sparingly if present at all. Dense layer societies of ferns and of Trichocladus occur.

The community constitutes the greater portion of the climax Forests. In it regeneration stages of P. Thunbergii Hook. are exceedingly well represented, those of Olea laurifolia scarcely as well. Seedlings, saplings and poles of Apodytes, Ocotea, Pterocelastrus, Curtisia, Celastraceae, occur in large numbers.

The rates of growth of the seedling, sapling and poles stages are low [*vide* Chapter 9, section (*b*)] owing to the very strong reaction of the large trees and shrubs upon the light, to the strong competition for soil moisture and solutes, and to the competition for growing space itself.

The percentage distribution transects described in this Chapter [*vide* Tables XXXIII–XXXVI (pp. 183-186] to a great extent traversed communities of this type.

3. *The Faurea McNaughtonii—other species association.*

This association is represented in a single Forest at the Knysna only—that of "Lilyvlei," Gouna Reserve. The Faurea has an interesting distribution (*vide* Chapter 6, p. 155), described elsewhere by J. F. Pillips [1927 (1)], and previously referred to by Kotze and E. P. Phillips (1919, 232-233, 235-238; and 1920, 221.).*

In the "Lilyvlei" Forest Faurea occurs in portions as a dominant in the Podocarpus Thunbergii—*Olea laurifolia—other species association*, in other it is a mere sub-dominant within the same community.

The tree attains a height ranging from 50-70 feet, and girths running from 4 to 10 feet. The boles are upright, cylindrical, massive, the crowns well balanced. The foliage of young stage regeneration is entirely different in appearance from that of the adult tree: in the former the leaves are linear, in the latter broadly lanceolate.

Regeneration is plentiful despite the low fertility of the seed (*vide* Appendix 1, Table 5, therein). The rate of growth in all stages is moderately fast.

The origin of the interesting community is not known.

Specific Constitution of the Tree and Large Shrub Layers.

A very fair impression of the constitution of the tree and large woody shrub layers of the climax and semi-climax Forests of the Knysna is to be obtained from the data yielded by lengthy transects. Frequency transects several miles in length and from 22 to 44 yards in width, on which all tree species and the more important species of large woody shrubs above 1 inch diameter at breast, height, were recorded, show the data set forth in *Table XXXIII* (p. 183).

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* Typed correction, June, 1920.

Table XXXIII.

PERCENTAGE FREQUENCY OF CHIEF SPECIES OF TREES AND SHRUBS (ALL INDIVIDUALS FROM 1 IN. DIAMETER AT $4\frac{1}{4}$ FT).

No.	Species.	Gouna. Fo. Fd.*	Deep-walls. Fm. Fo.	Kaffir-kop. Fd. Fo.	Harker-ville. Fo. Fm.	Blaauw-krantz. Fo. Fd.	Lotter-ing. Fo. Fd.	Storms-River. Fo. Fm.
1	Podocarpus Thunbergii, Hook.	9·82	8·76	11·51	9·31	6·43	6·09	5·70
2	Podocarpus elongata, L' Herit.	0·71	1·06	0·68	0·41	0·47	0·25	0·43
3	Olea laurifolia............	17·77	10·31	19·48	11·27	9·74	10·33	8·05
4A	Olea capensis............	5·60	7·18	5·21	10·77	4·84	5·20	5·28
4B	Olea foveolata............	0·20	—	0·70	0·82	1·00	2·00	1·50
5	Gonioma Kamassi.........	17·54	4·70	10·93	10·29	9·36	10·48	7·62
6	Apodytes dimidiata.......	4·70	9·53	3·85	4·45	9·39	5·04	4·68
7	Ocotea bullata............	3·16	2·51	1·36	2·19	2·05	2·19	5·18
8	Curtisia faginea...........	4·69	6·13	5·21	3·24	6·60	3·56	7·50
9	Platylophus trifoliatus.....	1·65	11·51	0·93	3·88	2·71	4·98	10·13
10	Cunonia capensis..........	—	0·27	0·06	1·41	0·38	1·37	0·71
11	Pterocelastrus variabilis...	4·41	0·98	6·51	8–68	11·15	19·56	8·50
12	Elaeodendron croceum.....	2·94	4·43	4·46	4·10	4·70	3·87	2·28
13	Celastrus acuminatus......	1·23	3·34	1·91	2·35	2·15	3·06	2·80
14	Celastrus peduncularis.....	1·18	1·32	1·18	0·86	1·04	0·67	1·28
15	Plectronia obovata........	3·00	1·90	4·05	2·90	2·66	1·87	1·78
16	Plectronia Mundtii........	1·48	1·00	1·38	1·42	2·41	2·11	3·77
17	Burchellia capensis........	7·63	5·22	5·39	3·17	5·88	5·22	9·03
18	Faurea McNaughtonii.....	1·18	—	—	—	—	—	—
19	Olinia cymosa............	—	—	0·28	0–37	—	0·12	0·83
20	Ochna arborea............	1·42	0·08	3·59	3·77	0·55	1·22	0·50
21	Lachnostylis capensis......	0·30	0·81	3·21	0·76	0·32	1·00	0·30
22	Myrsine melanophleos.....	0·68	—	0·14	2·72	0·25	1·90	1·18
23	Ilex (capensis) mitis	0·24	1·46	0·37	1·85	1·07	1·11	0·44
24	Nuxia floribunda..........	2·27	3·42	0·90	1·43	5·03	1·74	4·10
25	Royena lucida............	3·11	4·52	3·72	2·66	2·76	1·37	2·33
26	Halleria lucida............	1·73	9·56	2·63	1·49	6·65	1·49	3·78
27	Other species.............	1·30	—	0·36	3·43	0·41	2·20	0·29
		100·00	100·00	100·00	100·00	100·00	100·00	100·00

* Forest types best represented.

Fd. — Dry type (holard = 25–35%).

Fo — Medium-moist type (holard = 45–60%).

Fm. — Moist type (holard = 85–170%) [*vide* J. F. Phillips, 1928; (6).]

It is seen from these data that Olea laurifolia, P. Thunbergii Hook., Gonioma Kamassi, and Pterocelastrus variabilis are the most abundant species of trees. It is to be noted that the moist Forests are richer in Platylophus trifoliatus and poorer in Olea laurifolia than the dry.

The absolute density of the stocking in undisturbed Forest, so far as the trees and large woody shrubs are concerned, varies with the locality and with the ecological type. Thus the *Platylophus consocies* shows few stems to the acre, whereas the *Olinia cymosa consocies* shows a considerable number, but not as many as the *Pterocelastrus variabilis consocies* or the *Celastraceae—other species associes.* The following absolute density (or absolute frequency) data for several portions of Forest are of interest—all stems of trees and important woody shrubs, over 1 inch in diameter at breast-height being recorded:—

Name of Forest Reserve.	Nature of Forest.	Mean Absolute Density, i.e. Total Number of Stems (above 1 inch diameter) per Acre.
Deepwalls................	Vide *Table XXXIII* (p. 183) and maps of the Knysna region	474·5
Gouna....................	—	521·2
Harkerville...............	—	574·9
Kaffirkop.................	—	630·6
Blaauwkrantz............	—	441·1
Lottering.................	—	842·5
Storms River............	—	694·5

The specific stocking for 2-acre portions of three different Forests —Kaffirkop, Deepwalls, and Gouna—is given in Tables XXXIV-V-VI:—

Table XXXIV.

SPECIES AND NUMBERS OF TREES OCCURRING ON 2 ACRES OF FOREST, KAFFIRKOP, 1,000 FT.

Species.	Diameter Classes.																		
	1–3	3–5	5–7	7–9	9–11	11–13	13–15	15–17	17–19	19–21	21–23	23–25	25–27	27–29	29–31	31–33	33–35	35–37	Total.
Olea laurifolia	50	26	12	14	12	15	6	7	7	2	2	1	1	—	—	—	—	—	155
Gonioma Kamassi	52	29	13	8	2	—	—	—	—	—	—	—	—	—	—	—	—	—	104
Podocarpus Thunbergii, Hook.	30	16	5	9	11	9	9	3	—	1	—	1	—	—	—	—	—	—	94
Burchellia capensis	66	23	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	91
Apodytes dimidiata	39	19	4	1	2	3	1	—	—	—	—	—	—	—	—	—	—	—	69
Curtisia faginea	24	11	4	9	6	4	—	1	—	—	—	—	—	—	—	—	—	—	59
Olea capensis	16	24	3	8	3	1	—	1	1	—	—	—	—	—	—	—	—	—	57
Royena lucida	27	16	4	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
Plectronia obovata	21	6	2	4	3	2	3	2	2	—	—	—	—	—	—	—	—	—	45
Ochna arborea	20	15	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	37
Pterocelastrus variabilis	9	4	4	6	4	4	3	2	—	—	—	—	—	—	—	—	—	—	36
Elaeodendron croceum	24	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28
Ocotea bullata	11	2	1	2	2	1	—	2	—	—	—	—	2	—	—	—	—	1	28
Lachnostylis capensis	8	4	6	4	1	1	—	—	—	—	—	—	—	—	—	—	—	—	24
Nuxia floribunda	11	3	4	4	—	—	1	—	—	—	—	—	—	—	—	—	—	—	23
Halleria lucida	12	6	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21
Royena pallens																			
Gardenia Rothmannia																			
Olea foveolata	16	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17
Kiggelaria africana																			
Fagara Davyi																			
Plectronia Mundtii	5	5	4	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	15
Celastrus acuminatus	1	4	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	7
Celastrus peduncularis	3	2	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	7
Podocarpus elongata, L'Herit.	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Ilex (capensis) mitis	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
	451	219	74	74	48	41	23	18	10	3	2	2	3	—	—	—	—	1	969

Table XXXV.

SPECIES AND NUMBERS OF TREES OCCURRING ON 2 ACRES OF FOREST, DEEPWALLS, 1,400 FT.

Species.	Diameter Classes.																								Total.
	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	
Halleria lucida	82	41	21	13	6	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	167
Platylophus trifoliatus	42	31	24	17	8	7	3	2	2	4	5	—	—	2	1	—	1	—	—	1	1	—	—	—	151
Apodytes dimidiata	39	23	20	3	6	6	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100
Curtisia faginea	23	7	13	8	4	3	2	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	63
Olea capensis	26	19	13	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60
Olea laurifolia	6	14	10	5	3	1	1	4	4	4	—	3	1	1	—	—	—	—	—	—	—	—	1	—	58
Nuxia floribunda	14	17	10	6	3	3	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	57
Burchellia capensis	44	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	55
Royena lucida	28	15	4	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	51
Ocotea bullata	5	5	1	1	3	3	—	2	1	—	1	1	—	—	1	—	1	—	—	1	—	—	—	—	26
Celastrus peduncularis	6	9	3	3	2	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24
Podocarpus Thunbergii, Hook	3	2	2	3	2	2	1	1	1	1	1	—	—	2	—	—	1	—	—	—	—	—	—	—	22
Plectronia Mundtii	7	1	3	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15
Elaeodendron croceum	9	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13
Celastrus acuminatus	5	4	3	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13
Ilex (capensis) mitis	4	—	3	—	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10
Gonioma Kamassi	7	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
Olea foveolata Kigelaria africana Fagara Davyi Gardenia Rothmannia	6	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
Podocarpus elongata, L'Herit	2	2	2	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
Plectronia obovata	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Pterocelastrus variabilis	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
	358	210	134	68	41	31	12	13	11	10	8	4	1	5	2	—	3	—	—	2	1	—	1	—	915

Table XXXVI.

SPECIES AND NUMBERS OF TREES OCCURRING ON 2 ACRES OF FOREST GOUNA, 1,400 FT.

Species.	Diameter Classes.																					
	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	Total.
Gonioma Kamassi	96	42	17	6	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	163
Pterocelastrus variabilis	44	21	18	16	14	11	4	2	3	—	—	—	—	—	—	—	—	—	—	—	—	133
Olea laurifolia	48	15	7	8	11	10	5	4	3	1	1	1	—	1	—	—	—	—	—	—	—	115
Podocarpus Thunbergii, Hook	15	9	10	7	7	5	4	3	3	3	1	—	1	—	—	—	—	—	—	—	—	68
Curtisia faginea	13	12	8	8	—	7	6	2	—	1	1	—	—	—	—	—	—	—	—	—	—	58
Burchellia capense	19	24	4	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	49
Elaeodendron croceum	26	6	5	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	41
Apodytes dimidata	8	11	6	1	1	4	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	35
Nuxia floribunda	9	5	3	8	2	3	1	3	—	1	—	—	—	—	—	—	—	—	—	—	—	35
Olea capensis	15	13	4	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	33
Plectronia Mundtii	20	9	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	33
Plectronia obovata	8	6	4	3	1	3	1	2	1	—	—	—	—	—	—	—	—	—	—	—	—	29
Cleastrus peduncularis	13	3	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21
Ochna arborea	9	9	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
Royena lucida	11	5	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
Halleria lucida	5	5	4	3	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
Ocotea bullata	3	3	3	2	—	3	1	—	—	1	—	1	2	—	—	—	—	—	—	—	—	19
Celastrus acuminatus	2	4	1	3	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	12
Podocarpus elongata, L'Herit	1	1	2	—	—	—	—	—	—	1	—	—	—	—	2	—	—	—	—	—	1	8
Fagara Davyi	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6
Ilex (capensis) mitis	—	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
Myrsine melanophleos	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Elaeodendron kraussianum	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
	375	206	104	72	43	50	27	18	11	8	3	2	3	1	2	—	—	—	—	—	1	926

In connection with the absolute density data given above, and the specific stocking data given in *Tables XXXIII-XXXVI* (pp. 183-186) it must be remembered that in addition to the trees and large shrubs over 1 inch in diameter at breast-height, there were considerable numbers of saplings and seedlings of the species listed, and dense layer societies of Trichocladus, many minor shrubs (e.g. Carissa arduina, Celastrus buxifolius, C. nemorosus, Rhamnus prinoides, Cluytia pulchella, Polygala myrtifolia, Osteospermum moniliferum, Sparmannia africana, Brachylaena neriifolia), numerous herbaceous shrubs (e.g. Plectranthus fruticosus, Piper capense), geophytes (Moraea iridioides, Aristea pusilla), various lianes (Clematis, Secamone, Cynanchum, Sarcostemma, Ficus Burtt-Davyi, Scutia), and epiphytes (Cryptogamic, Orchidaceous, and Peperomia spp.)—making the total plant population very large indeed.

The specific stocking varies little according to *altitude*, within the main Forest, but montane Forest is markedly different in composition from that of the latter. Montane Forest is generally rich in Platylophus and Cunonia; Ocotea, Ilex and Apodytes are numerous in parts, but Olea laurifolia, Curtisia, Gonioma and other species favouring the drier localities, are not well represented. The margins of montane Forest are marked by a luxuriance of Sparmannia, Gleichenia polypodioides, Marattia, and Todea barbara.

Aspect differences are rather more strongly marked. The specific stocking varies as the aspects change. The N., N.E., and N.W. aspects are the warmer and drier ones, the S., SE., and S.W. the cooler and moister, while the E. and W. may be considered as being intermediate. Other factors being equal, Olea laurifolia, Gonioma, Curtisia, Olinia, Pterocelastrus, Celastrus spp. are better developed on N., N.E., and N.W. aspects; Platylophus, Cunonia, Apodytes, Ilex, Ocotea, on the S., S.E., and S.W.

The percentage distribution of species according to *aspect*, for a portion of the Sourflats Forest, Knysna, is given in *Table XXXVII*.

Table XXXVII.

PERCENTAGE FREQUENCY OF SPECIES ACCORDING TO ASPECT, SOURFLATS FOREST.

Species.	Aspect.							
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
Podocarpus Thunbergii Hook....	16·30	8·35	7·24	5·32	13·05	8·82	9·17	13·49
Podocarpus elongata L'Herit....	·76	1·14	1·37	·46	·58	·28	·30	·78
Olea laurifolia..................	23·30	23·68	18·39	17·44	11·55	14·28	10·06	19·50
Olea capensis..................	4·18	·93	1·96	2·94	9·35	4·85	9·76	5·76
Gonioma Kamassi..............	15·46	11·98	13·50	15·04	15·70	16·13	18·34	15·39
Apodytes dimidiata.............	2·72	5·99	7·05	5·93	1·96	4·74	1·48	3·16
Ocotea bullata..................	4·78	3·64	2·94	3·78	6·58	4·52	6·80	2·97
Curtisia faginea................	4·18	5·92	6·26	5·67	2·54	3·53	2·66	4·80
Platylophus trifoliatus..........	·23	·21	1·37	7·53	2·66	8·99	—	3·07
Cunonia capensis...............	·21	·07	—	·08	1·96	·44	1·18	·23
Pterocelastrus variabilis.........	5·87	4·64	6·85	5·53	17·20	9·40	15·68	9·97
Elaeodendron croceum..........	4·78	3·35	2·74	4·03	5·89	3·14	4·14	3·54
Celastrus aciminatus............	1·07	·93	·39	1·09	·35	2·10	2·37	1·42
Celastrus penduncularis..........	1·01	·78	·39	1·46	5·54	·63	·89	·55
Plectronia obovata..............	2·72	3·64	2·74	2·54	1·96	2·81	2·37	2·70
Plectronia Mundtii..............	·72	1·78	2·94	1·15	·23	·58	·89	·55
Olinia cymosa..................	·17	1·14	—	—	·23	—	—	·09
Ochna arborea..................	·23	1·00	·19	·40	—	·39	—	·04
Lachnostylis capensis...........	·50	—	—	—	—	·17	1·48	·73
Myrsine melanophleos...........	·80	—	·19	·02	·35	·17	2·37	·43
Ilex (capensis) mitis............	·93	·78	1·00	1·23	·23	2·01	2·37	1·81
Nuxia floribunda...............	1·16	3·92	4·30	2·92	·46	1·93	2·96	·71
Royena lucida..................	2·27	3·71	3·52	3·13	—	2·04	·89	1·90
Halleria lucida..................	1·18	4·00	6·07	4·99	·81	2·42	2·07	1·88
Burchellia capensis.............	3·61	7·99	8·21	6·74	·58	4·99	1·77	4·28
Other species..................	·86	·43	·39	·58	·24	·64	—	·25
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

The table gives a *general impression of the change with aspect*, but must not be considered as showing the average percentage distribution according to aspect, for the whole of the Forests of the Knysna, for conditions of community as well as edaphic and climatic factors of the particular habitat, have to be taken into account site by site.

Minor Communities.

In addition to the upper layers composed by large trees and large woody shrubs, there are several minor communities that deserve brief description.

(*a*) *Lower Layer Societies.*

The number of important lower layer societies is small, the best developed being the following:—

(1) *The Trichocladus crinitus layer societies* frequent in Forests on dry and medium-moist soils; this society is always under canopy.

(2) *The Hemitelia capensis layer societies* frequent in Forests of moist nature; this society is always under canopy.

(3) *The Blechnum capense layer societies* frequent in Forests of medium-moist and moist nature; this society is always under canopy.

(4) *Todea barbara and Marattia fraxinea layer societies* in moist Forest; these societies are usually under canopy.

(5) *Piper capense layer societies* frequent in medium-moist and moist Forest—always under canopy.

(6) *The Plectranthus fruticosus layer societies* characteristic of moist Forest, and less luxuriant in medium-moist Forest; always under canopy, except in portions of Forest exploited or burnt.

(7) *Mixed layer societies* (composed of such species as Rhamnus prinoides, Polygala myrtifolia, Cluytia pulchella, Carissa arduina, Celastrus nemorosus, Euclea macrophylla (smaller, Royena glabra), occur in portions of Forest where layers (1), (2), and (6) above are not well represented. Such layer societies occur under canopy.

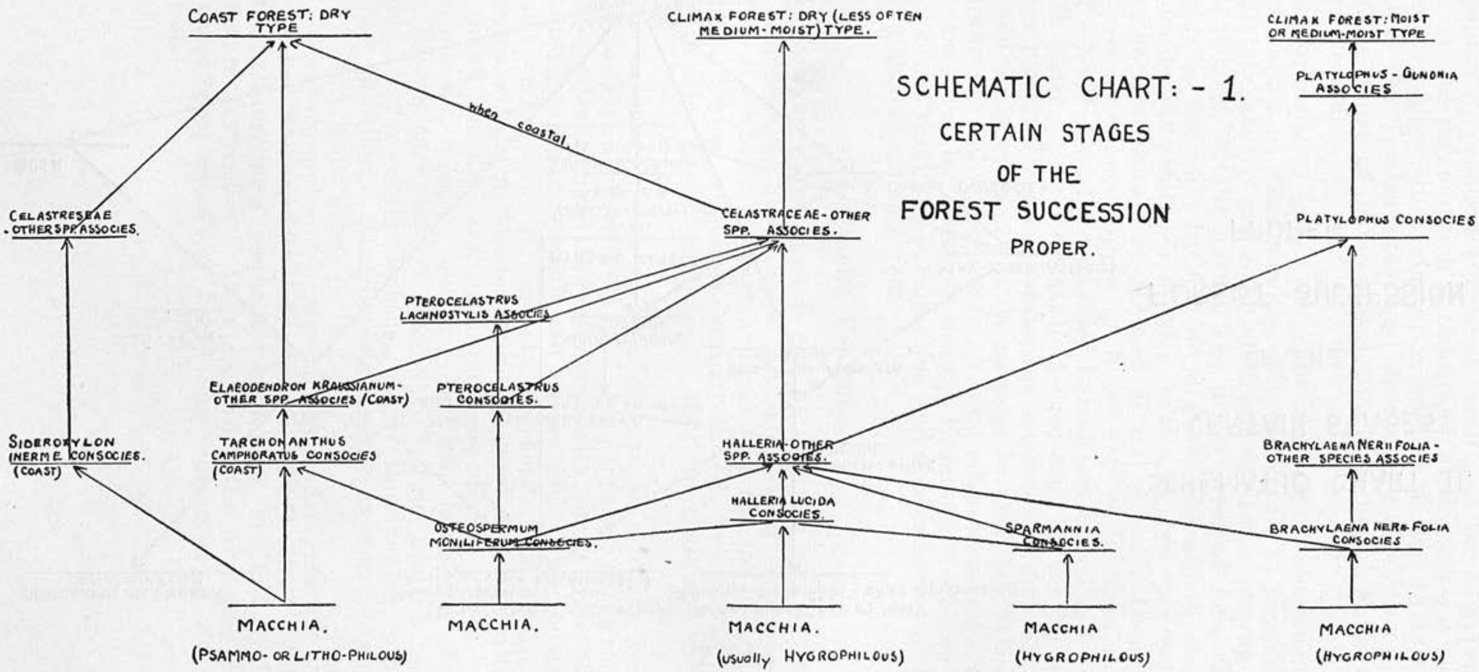
(8) *The layers of open portions of the Forest* are described in Chapter 10.

The layer societies (1) and (2) above are referred to in several places in this paper, but a brief account of their influence in the life-history of the Forest organism is not out of place at this stage.

Experimental work at Deepwalls is showing that these two layer societies are among the most potent biotic conditions controlling the natural regeneration of Forest trees. Briefly the position is as follows:—

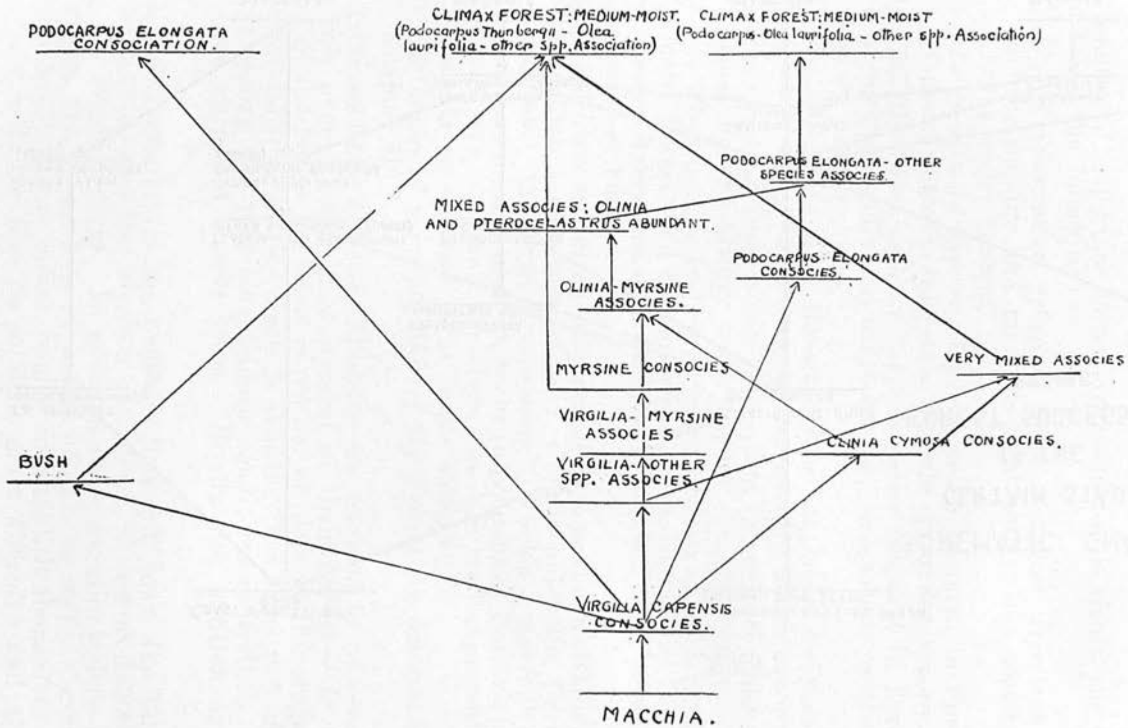
Trichocladus crinitus forms societies that cut down the light-intensity at, and several feet above ground-level, as low as 1/200 to 1/500, on the brightest days. In addition these societies reduce the soil-moisture in the upper 6 to 12 inches of soil, to such an extent that delicate seedlings are either unable to establish themselves on emerging from seeds, or else do so with great difficulty and grow extremely slowly. Elimination of the Trichocladus layers as pointed

XXV.



SCHEMATIC CHART: - 1.
CERTAIN STAGES
OF THE
FOREST SUCCESSION
PROPER.

XXVI.



SCHEMATIC CHART II

CERTAIN STAGES

OF THE

FOREST SUCCESSION

PROPER

out in Appendix 3, produces beneficial results, so far as appearance and growth of tree regeneration is concerned, within several months. Increased light supply (the value at ground-level rises to 1/30-1/60 on removal of the Trichocladus) and decreased competition for the moisture of the upper 12 inches of soil, appear to be the direct causes of this improvement.

Hemitelia capensis, so far as the light-intensity is concerned, acts in the same manner as Trichocladus, only the values at ground-level and immediately above, are reduced much further—ranging from 1/500 to 1/1200 on bright days. The dense cover of fern reduces evaporation from the soil; little wind disturbs the almost stagnant air; the relative humidity is usually within a few per cent. of saturation; the temperature of air and of soil is low. In addition the ferns shed a copious supply of litter and build upon an acid humus (pH 4.8-pH 4.4); the increased humus produces a soil heavily charged with water. (120 per cent. to 200 per cent. on the dry-weight of ovened samples.) Fungous diseases are often severe under cover of the ferns, and such seedlings as do manage to establish themselves despite the uncongenial light, humidity, and edaphic conditions, are frequently destroyed by these diseases. Elimination of the ferns produces beneficial results in germination and establishment of Forest forms, within the course of a year.

(*b*) *Ground Vegetation*.

The flora of the Forest floor is not particularly rich in species. Seedlings of the various Forest trees and large woody shrubs are well represented on the whole. Important plants are the following:—

Knowltonia glabricarpellata, K. rigida, and K. vesicatoria, forming societies in drier Forest, particularly near the coast and on warm ridges inland.

Aspidium capense, Blechnum punctulatum, B. australe, forming societies in drier Forest; Pteridium aquilinum forming dense societies on opener sites in both moist and medium-moist Forest; Lycopodium cernuum forming prostrate societies on opener sites, moist or dry.

Hypoestes verticillata, H. aristata, Gerbera cordata, G. piloselloides, Ficinia sylvatica, Moraea iridioides, and Aristea pusilla are commonly found on dry and medium-moist Forest floors, while Impatiens capensis, Scirpus tenellus, Mariscus congestus, Ficinia capillifolia, Juncus capensis var. flaccidus, Scirpus prolifer, Juncus lomatophyllus, Hydrocotyle asiatica, and Ranunculus pinnatus frequent moist positions. Zantedeschia aethiopica forms extensive societies in opener, moist sites.

The following examples of analyses of ground vegetation according to the method of Raunkiär (*vide* Smith, W. G. 1913, 22-26 for an account of Raunkiär's methods) employing analysis-circles of 1 sq. metre, are instructive. It is seen that the exploited Forest shows a larger proportion of herbaceous forms than does the natural Forest.

Natural Forest at Harkerville. Species occurring (no plants over 10 feet in height recorded).	Number of 1-sq. metre circles on which they occurred out of a possible 100.
Plectronia Mundtii seedlings	80
Trichocladus crinitus seedlings	68
Myrsine melanophleos seedlings	68
Moraeae iridioides (geophyte)	56
Celastrus acuminatus seedlings	48
Apodytes dimidiata seedlings	46
Zehneria obtusiloba (liane)	42
Royena lucida seedlings	38
Secamone Alpini (liane)	36
Burchellia capensis seedlings	34
Blechnum punctulatum	34
Polystichum pungens	34
Elaeodendron croceum seedlings	32
Plectranthus fructicosus	30
Carex aethiopica	30
Podocarpus Thunbergii Hook seedlings	28
Oxalis sp. (no flowers)	26
Asparagus sp. (no flowers)	24
Aspidium capense	22
Blechnum capense	22
Olea laurifolia seedlings	20
Galopina circaeoides	20
Scutia Commersonii (S. indica) (liane-form)	18
Cluytia pulchella	16
Pterocelastrus variabilis seedlings	14
Gonioma Kamassi seedlings	14
Celastrus buxifolius seedlings	14
Hemitelia capensis	12
Pyrenacantha scandens (liane)	12
Trimeria alnifolia seedlings	10
Ochna arborea seedlings	8
Rhoicissus capensis	8
Ocotea bullata seedlings	8
Impatiens capensis	8
Ilex mitis seedlings	6
Aristea pusilla (geophyte)	6
Rubus pinnatus	4
Kiggelaria africana seedlings	3
Celastrus peduncularis seedlings	3
Elaphoglossum conforme (on ground)	3
Curtisia faginea seedlings	2
Gerbera cordata	2
Ekebergia capensis seedlings	2
Carissa arduina	2
Exploited Forest adjacent to above.	
Plectranthus fruticosus	80
Blechnum punctulatum	50
Cluytia pulchella	44
Plectronia Mundtii seedlings	42
Trichocladus crinitus seedlings	40
Aspidium capense	40
Moraea iridioides (geophyte)	38
Halleria lucida seedlings	38
Polystichum pungens	37
Galopina circaeoides	32
Burchellia capensis seedlings	32
Ilex mitis seedlings	27
Helichrysum petiolatum	26
Carex aethiopica	24
Olea laurifolia seedlings	24
Myrsine melanophleos seedlings	24
Apodytes dimidiata seedlings	23
Royena lucida seedlings	22
Oxalis sp. (no flowers)	21
Osteospermum moniliferum	20
Asparagus sp. (no flowers)	18
Clematis brachiata (liane)	17
Cluytia affinis	14
Rubus pinnatus	14
Pyrenacantha scandens	15
Helichrysum diffusum	14
Podocarpus Thunbergii Hook seedlings	14
Impatiens capensis	13
Ocotea bullata seedlings	12
Nuxia floribunda seedlings	12
Ochna arborea seedlings	10
Kiggelaria africana seedlings	10

Exploited Forest adjacent to above (*continued*). Species occurring (no plants over 10 feet in height recorded).	Number of 1-sq. metre circles on which they occurred out of a possible 100.
Physalis pubescens (P. peruviana) (exotic)	9
Blechnum capense	8
Curtisia faginea seedlings	8
Aristea pusilla (geophyte)	8
Platylophus trifoliatus seedlings	6
Senecio quinquelobus (liane)	6
Zehneria scabra (liane)	6
Wahlenbergia procumbens	6
Secamone Alpini (liane)	6
Rhamnus prinoides seedlings	6
Hemitelia capensis	6
Rubus fruticosus (exotic)	6
Piper capense	4
Pteridium aquilinum	4
Celastrus peduncularis seedlings	4
Celastrus buxifolius seedlings	4
Elaeodendron croceum seedlings	4
Trimeria alnifolia seedlings	3
Gerbera cordata	3
Dolichos gibbosus (liane)	3
Carissa arduina	3
Helichrysum foetidum	3
Cissus cuneifolia	2
Olea capensis seedlings	2
Celastrus acuminatus seedlings	2
Sonchus oleraceus (exotic)	2
Hydrocotyle asiatica	2
Solanum nigrum	1
Pterocelastrus variabilis seedling	1
Passiflora quadrangularis (liane) (exotic)	1

(*c*) *Lianes.*

Contrasted with the subtropical Forests of Natal and Zululand and with those of the Transkei and Kaffraria, the Knysna Forests are remarkably poor in all lianoid growths; the poverty is still more pronounced when the lianoid flora of the tropical African Forests is contrasted with that of the Knysna.

As the woody liane is probably the most primitive form of liane, it is rather surprising that the Knysna Forests should show so few species. It is difficult to understand why Popowia, Dalbergia, Strophanthus, Behnia, which are in the Eastern Forests, do not appear at Knysna; they have not (except Behnia) even reached the Alexandrian Forests about 50 miles East of Port Elizabeth.

While the woody form is probably relatively primitive among lianes, it is interesting to note that the Knysna species, except Clematis and Capparis citrifolia, belong to comparatively high developed families. The non-woody twiners, except Cissampelos and Antizoma capensis (Menispermaceae), too, belong to families fairly high in the phylogenetic scale. There are no endemic lianes, all the species occurring, being wide ranging Eastward and some of them proceeding even Westward.

If the lianes are few in species they are certainly very abundant in numbers of individuals, most portions of the Forests being festooned with Clematis, Asclepiadaceous lianes, Rhoicissus capensis, and others rendered impassable by Scutia, Capparis, and Rubus pinnatus. The undergrowth is usually bound by tangles of Zehneria and Pyrenacantha. The total damage done to saplings and poles by lianes is probably quite considerable, numerous malformed stems being found on every acre.

For the sake of ready reference the principal lianes are listed below:—

WOODY LIANES.

Clematis brachiata * (Ranunculaceae): stem from 1 to 3 inches diameter.
Capparis citrifolia (Capparidaceae): armed.
Scutia Commersonii (S. indica) (Sapindaceae): armed, kills many trees; at times takes shrub form.
Rubus pinnatus (Rosaceae): armed.
R. rigidus: armed, commoner in coastal Forest.
R. fruticosus: this armed exotic at times takes liane form, ascending many feet and doing much harm to young trees.
Grewia occidentalis (Tiliaceae): scandent shrub, commoner near coast.
Secamone Alpini (Asclepiadaceae): stems from 1 to 3 inches diameter, does much harm to trees; much sought by elephant.
Ficus capensis (Moraceae): occasionally assumes lianoid form; does much damage to trees.
F. Burtt-Davyi: does much damage.
Rhoicissus capensis (Vitaceae): very abundant in opener Forest and near the coast; forms dense cover over trees; does much harm.
R. digitata is frequent on the coast and in opener inland Forest.
Cissus cuneifolia occurs principally in coastal Forest.
Senecio angulatus: frequent in coastal Forest.
S. mikanioides: frequent in coastal Forest.
S. quinquelobus: frequent in coastal Forest.
S. deltoideus: occurs toward the Eastern limit of the region.
Mikania capensis: frequent in all Forests.
Vernonia anisochaetoides: abundant in open Forest.
†Asparagus spp. (Liliaceae): twiners best developed in dry Forest.

NON-WOODY OR ONLY SLIGHTLY WOODY LIANES.

Antizoma capensis (Menispermaceae): occasional.
Cissampelos torulosa (Menispermaceae): frequent.
Fagelia bituminosa (Leguminoseae): frequent on coast only.
Dolichos gibbosus (Leguminoseae): frequent in open Forest.
Astephanus neglectus (Asclepiadaceae): frequent.
A. marginatus (Asclepiadaceae): frequent.
Cynanchum obtusifolium (Asclepiadaceae): frequent.
Tylophora syringaefolia (Asclepiadaceae): frequent.
Tylophora sp. (Asclepiadaceae): frequent.
Sarcostemma viminale (Asclepiadaceae): frequent on coasts; succulent and leafless.
Zehneria (Melothria) obtusiloba (Cucurbitaceae): very abundant.
Zehneria (Melothria) hederacea (Cucurbitaceae): very abundant.
Zehneria (Melothria) punctata (Z. scabra) (Cucurbitaceae): very abundant.
Pyrenacantha scandens: very abundant.

MISCELLANEOUS CLIMBERS.

Pollinia nuda (Gramineae).
Gleichenia polypodioides (Gleicheniaceae).

* *C. brachiata Thunb.* including *C. Thunbergii Steud*, which cannot be distinguished satisfactorily.
† *Cussonia thyrsiflora* is sometimes lianoid, trailing long distances up rocks and ascending trees.

(*d*) *Epiphytes.*

At the Knysna epiphytes are abundant as to numbers of individuals but poor as to numbers of species. Bews (1925: 95) in discussing woodland epiphytes in South Africa generalizes that epiphytes are few in species and not abundant individually. So far as the writer is able to state from his own observations, the Pirie, Amatola, and Alexandrian Forests of the Eastern Cape Province certainly are poor in numbers of epiphytes. The Knysna Forests, however, are much richer in numbers of individuals—in moister portions almost every tree shows epiphytic societies poor in numbers of species rich in numbers of individuals.

The epiphytic habit is probably a derivative one, infinitely better represented specifically in the tropical African Forests.

The epiphytic flora within the Knysna Forests is as follows:—

Cryptogamic epiphytes.	Remarks.
Usnea barbata Fries	This Ascolichen (Discolichenes . . . thallus heteromerous) is widespread, particularly on Podocarpus spp. and Apodytes crowns. The fungal component often acts semi-parasitically on the outer bark of the supporting tree.*
Porothamnium pennaeforme	This moss drapes the lower layers in moist portions of the Forests.
Lycopodium gnidioides	Particularly on Ocotea bullata.
Polypodium ensiforme.	
P. lanceolatum	Often terrestial (old wood).
P. lanceolatum var. sinuatum	,, ,,
P. lineare	,, ,,
Elaphoglossum conforme	,, ,,
E. petiolatum	,, ,,
Asplenium gemmiferum	,, ,,
A. bipinnatum	,, ,,
Vittaria isoetifolia	Particularly on Ocotea bullata.
Orchidaceous epiphytes.	**Remarks.**
olystachya Ottoniana	Sometimes terrestial (old wood).
ngraecum bicaudatum	Rarely terrestial (on old wood).
A. Burchellii	,, ,,
A. conchiferum	,, ,,
A. pusillum	,, ,,
A. sacciferum	,, ,,
Mystacidium filiforme	,, ,,
Calanthe natalensis	Frequently terrestial (on old wood).
Listrostachys arcuata	Rarely terrestial.
Dicotyledonous epiphytes.	**Remarks.**
Streptocarpus Rexii	Particularly on boles of Ocotea.
Peperomia reflexa	Often on old wood on ground.
P. retusa	Often on old wood on ground (more local).
Ficus capensis and F. Burtt-Davyi	These species are very variable in their form; they may commence life as epiphytes and later become parasites, and still later, self-dependent trees or scandent shrubs,

* *Vide* Phillips, 1929.

The epiphytes in the Knysna Forest, on the whole, do not show very marked preferences for particular species of trees, except that Ocotea is preferred by Streptocarpus and Lycopodium guidioides.

This subject of preference for particular supporting plants, however requires to be studied along the same lines as those adopted by L. J. Pessin (1925: 17-37.) in his thorough investigation of Polypodium polypodioides and its preferences.

S., S.E., and S.W. sides of trees are preferred at the Knysna, owing to their being slightly cooler and moister.

A point of interest is the occurrence of Pepromia reflexa and Peperomia retusa and Calanthe natalensis as terrestial plants, this occurrence possibly reflecting their phylogenetic history.

(*e*) *Phanerogamic parasites*..

The Forests of the Knysna are remarkably free from phanerogamic parasites, the only species occurring on trees or large shrubs being Viscum obscurum,* Cassytha ciliolata; Cuscata sp. nov. of Schönland, S. appendiculata, and C. africana (all on Virgilia capensis but doing little damage); the variable-formed Ficus capensis and F. Burtt-Davyi at times act as parasites.

* *Viscum obscurum*: On Olea laurifolia and Platylophus trifoliatus, the crowns of which suffer to some extent.

Fungous saprophytes and parasites are listed in Chapter VI.

Forest Types.*

The significance of the term "*Forest type*" has been much debated by American foresters within recent years. (*vide* Clements 1920: 337-344 for a concise account of the various views put forward.)

Briefly, the term as used by some foresters, is equivalent to "*site*" or "*locality*," but by the majority it is understood to refer to the "*cover*" or "*vegetation*"; unfortunately certain writers have employed the term in describing *successional stages*. In the present communication the term implies *forest of climax or semi-climax nature characterized by the mean moisture-content (holard) of the soil and by the resultant changes reflected in the vegetation both dominant and subdominant.* In a word, Mason's (1913: 91) and Greeley's (1913: 76) "physical" and "cover" types are both included in the meaning.

The Forest types defined within the Knysna region are:—†

(1) *The Forest of Dry Type.*

(2) *The Forest of Medium-moist Type.*

(3) *The Forest of Moist Type.*

Habitat modifications of the above types are as follows:—

(1) *Forest of Coastal Type* (shorter form of Types 1, 2, and 3 above).

(2) *Forest of Montane Type* (shorter form of Type 3 above).

As is implied by their names, the physical explanation of the separation of these types resides in different mean holard values, these differences being reflected either in the floristic composition (particularly in the lower layer and ground societies), or in the growth quality of the forest cover.

The five types above listed are described in tabular form:—The Types 1, 2, and 3 of the first series, are indicated on the vegetation maps of the region.

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* For a fuller account of the *Forest types* in the Knysna region and a discussion of the criteria employed, *vide* Phillips, 1928; (6). The cognate subject of *Plant Indicators* for the Knysna region is dealt with in Phillips, 1928; (5).

†*December*, 1930: F. S. Laughton, my successor at Deepwalls, has reclassified the types; for sake of obviating confusion in nomenclature I give Mr. Laughton's terms along with my own:—

Dry Type (J.P.) = *Dry Type* (F.S.L.).

Medium-moist Type (J.P.) = *Medium-moist* (F.S.L) and Moist Type (F.S.L.) *in part.*

Moist Type (J.P.) = *Moist Type* (F.S.L.) *in part.*
= *Wet Type* (F.S.L.).

Table XXXVIII.

Type.	Mean Holard at 18 Inches (dry-weight).	General Nature of the Soil.	Aspect Favoured.	General Position.	Floristic Features. Upper Layers. Absent Typically.	Floristic Features. Upper Layers. Present Typically.	Floristic Features. Lower Layers. Absent Typically.	Floristic Features. Lower Layers. Present Typically.	Nature of the Growth in the Upper Layers.
DRY*	25–35 %	Humus dry, its pH 5·5–7·3. Sandy-loam 18–24 inches deep, over Clay or broken rock, or pan of lateritic nodules. Usually a shallow soil; water often runs off humus surface as on a greased surface. *Dry* type Forest is well represented on soil overlying Bokkeveld beds.	N., N.W., W., but rarely S., S.E., and E.	Within several miles of the coast; along steep river gorges; on ridges of the plateaux; occasionally on shallow-soiled ridges of foothills.	Hygrophilous spp., chiefly Platylophus, Cunonia, Ilex; Ocotea may be present sparingly but is poorly grown.	All other tree spp., but notably Plectronia obovata, Lachnostylis, Pterocelastrus, Elaeodendron croceum, Olinia, Myrsine. Gonioma often abundant.	*Under Canopy,* Hemitelia capensis, Blechnum capense, luxuriant B. punctulatum, Todea barbara, Marattia fraxinea, Piper capense, Cyperaceae, except Ficinia leiocarpa and Schoenoxiphium lanceum. Epiphytic Polypodium and Elaphoglossum spp., the draping Moss, Porothamnium, pennaeforme. *Open Sites.* Sparmannia africana, Brachylaena neriifolia.	Dense societies of Trichocladus crinitus, bound together with such small lianes as Pyrenacantha scandens, Cynanchum, Melothria, Antizoma, and Cissampelos. Thorny shrubs (e.g. Carissa, Doryalis and Celastrus nemorosus and C. buxifolius) are abundant. Cassinopsis capensis is less frequently found. On the ground are Gerbera spp., Moraea iridiodes, small Blechnum punctulatum, B. australe. Common are Hypoestes verticillata, Knowltonia spp., and Ficinia leiocarpa. Aspidium capense is locally abundant.	The mature and semi-mature dominant trees are of lesser height and diameter than in the *Medium* and *Moist* types. The mean height of the top of the canopy ranges from 40 to 50 feet. Podocarpus elongata is rarely greater than 90–100 feet. Boles are often twisted in grain and much fissured; the wood is harder than in the other types, especially on the N. and N.W. sides of the trees and on the N. and N.W. aspects. Crowns are often stag-headed and the twigs dry; Usnea barbata decks the exposed crowns of Podocarpus spp. and of Apodytes. REGENERATION ABSENT OR SPARSE; Podocarpus spp. seedlings may be locally frequent.

* *Vide* Phillips, 1928; (6): 191–194.

Table XXXIX.

Type	Mean Holard at 18 Inches (dry-weight).	General Nature of the Soil.	Aspect Favoured.	General Position.	Floristic Features. Upper Layers. Absent Typically.	Floristic Features. Upper Layers. Present Typically.	Floristic Features. Lower Layers. Absent Typically.	Floristic Features. Lower Layers. Present Typically.	Nature of the Growth in the Upper Layers.
MEDIUM-MOIST.†	45–60 %	Humus medium moist, its pH 4·8–5·5. Sandy-loam or Clay-loam over Clay. Lateritic pan of nodules may be present, but is usually not thick. Usually a moderately deep to deep soil; not heavy and not cold. *Medium* type forest is found on some of the better class soils overlying Bokkeveld beds. It is found on soils over Pre-Cape beds and Granite; it is chiefly over steep-dipping T.M.S.	Any aspect.	From within a few miles of the sea to the foothills; not often on the lower mountain slopes. Not on ridges nor in moist nor dry valleys.	Platylophus, Cunonia—except far-scattered individuals near locally moisture sites. Olinia is rare except along the forest margins and in seral forest of *medium-moist* type. Pterocelastrus and Elaeodendron croceum much less frequent than in the *Dry* type. Elaeodendron Kraussianum never appears. Ilex may be scattered through the type but is not large.	All spp. may occur but the dominants are Podocarpus Thunbergii and Olea laurifolia; P. elongata may be locally dominant.	Hemitelia capensis, Marattia fraxinea, Todea barbara, in any abundance or luxuriance. Impatiens capensis, Hydrocotyle asiatica, Cyperus tenellus, Ficinia capillifolia, Scirpus prolifer, Juncus lomatophyllus, J. capensis, are are found in locally moist places only. Knowltonia spp., Euclea macrophylla, Cassine scandens, Royena pallens. Ficinia leiocarpa, except on small locally drier sites.	Blechnum capense, B. punctulatum, Aspidium capense (luxuriant in nature) abundant. Trichocladus crinitus abundant and of taller and stronger growth than in the *Dry* type. Plectranthus fruticosus abundant but not as tall and dense as in the *Moist* type. Epiphytic Polypodium and Elaphoglossum much less abundant and less luxuriant than in the *Moist* type. Hymenophyllaceae locally frequent only.	Variable, but on the whole infinitely better than in the *Dry* type. The best parts bear comparison with the best parts of the *Moist* type so far as Ocotea is corcerned. Platylophus is poorly grown. Excellent Podocarpus spp., Olea laurifolia and Apodytes occur; Gonioma is abundant, its growth better than in the *Dry* type. Timber of better quality than in the *Dry* type; the Stinkwood (Ocotea) not as good as in *Moist Forest*. REGENERATION EXCELLENT IN PARTS, IN OTHERS SPARSE. Seedlings of Podocarpus Thunbergii Olea laurifolia Apodytes dimidiata Celastraceae abundant in places.

NOTE TO TABULAR STATEMENT.

In general, the *Medium-moist* type is distinct from the *Dry* type in virtue of its taller, finer, better-crowned dominant, and sub-dominant trees, in virtue of its better regeneration of all stages, and on account of its deeper, moister, slightly more acid soil. The ground vegetation is more luxuriant than in the *Dry* type.

It is distinct from the *Moist* type in that it contains no (or very few) hygrophilous dominants and but few fern societies, Hemitelia layers being notably absent; its regeneration stages are better than in the *Moist* type, and the soil on which it grows is much less heavy, is less acid, and on the whole of better nature, than that of the *Moist* type.

* *Vide* Phillips, 1928; (6): 194–196.

Table XL.

Type.	Mean Holard at 18 Inches (dry-weight).	General Nature of the Soil.	Aspect Favoured.	General Position.	Floristic Features.				Nature of the Growth in the Upper Layers.
					Upper Layers.		Lower Layers.		
					Absent Typically.	Present Typically.	Absent Typically.	Present Typically.	
MOIST. *	85–170 %	Humus exceedingly moist, its pH 4·0–4·8. Sandy-loam over a Clay-loam over Clay; or Clay-loam over Clay. Drainage usually poor. Cold and heavy. *Moist type* rarely on soil overlying Pre-Cape or Granite; very rarely on that over Bokkeveld beds.	S., S.E., and S.W.	Along river beds; in moist kloofs, both on the plateaux and along the mountain sides.	Large individuals of other tree spp., especially of Podocarpus elongata, Olea laurifolia, Elaeodendron croceum, Pterocelastrus, Plectronia obovata. Notably absent are Olinia and Lachnostylis.	Platylophus, Cunonia, are abundant. Ilex mitis is locally frequent; Ocotea is scattered or locally frequent, in some sites Apodytes dimidiata and Olea laurifolia are found scattered. Some sites hold Cunonia and Platylophus only, others, these spp. and a scattering of many other spp. found in the *Medium* type. Gonioma is rare.	Trichocladus crinitus layers of any extent or of any luxuriance. Cassine scandens, Euclea macrophylla, and most of the thorny shrubs of *Dry* forest. Knowltonia, hypoestes Ficinia leiocarpa, Aspidium capense.	Dense societies of Hemitelia capensis, Blechnum capense, luxuriant B. punctulatum, Marattia fraxinea, Todea barbara, Epiphytic Polypodium and Elaphoglossum spp.: Hymenophyllaceae, and the luxuriant fruticose Lichens and the draping Moss Porothamnium pennaeforme. Terrestial Mosses abundant. Plectranthus fruticosus is abundant in opener sites; frequent are Sparmannia, Piper capense, Mariscus congestus, Carex aethiopica, Cyperus tenellus, Ficinia capillifolia, Scirpus prolifer, Juncus capensis, J. lomatophyllus and Zantedeschia aethiopica on open and very moist portions. Impatiens capensis and Hydrocotyle asiatica are abundant.	Variable; in sites excellent height and diameter growth are shown, especially by Ocotea and Cunonia, while some fine Ilex is sometimes found; the crowns are well developed and the boles are symmetrical; in other sites the growth is short and the crowns and boles asymmetrically shaped. Platylophus communities usually show strongly asymmetrical boles and crowns. Some of the finest Ocotea (Stinkwood) timber comes from *Moist* forest in the mountains. REGENERATION IS ABSENT OR VERY SPARSE, except where the ferns have been destroyed or where the upper canopy is lighter.

* *Vide* Phillips, 1928; (6): 196–198.

Table XLI.

Type.	Mean Holard at 18 Inches (dry-weight).	General Nature of the Soil.	Aspect Favoured.	General Position.	Floristic Features.				Nature of the Growth in the Upper Layers.
					Upper Layers.		Lower Layers.		
					Absent Typically.	Present Typically.	Absent Typically.	Present Typically.	
COAST.*	Varies with the Moisture type, the *Dry*, *Medium*, and *Moist* types being present. In places 25–35 % in others 35–60 %	Varies with topography but Sandy-loam is the best represented; its depth except on ridges and along ravine sides is considerable. The pH values naturally vary with the Moisture type, but in general the higher pH values apply.	Any, but generally S., S.W., S.E.	Within 1–3 miles of the sea, or on well sheltered, deeper soiled sites within a few hundred yards of the sea.	Varies with the Moisture type; the *Dry* and *Medium* types being much better represented than the *Moist*, the latter being confined to moist kloofs.	Varies with the Moisture type. Myrsine, Olinia, Elaeodendron Kraussianum, are not uncommon. Ekebergia, Sideroxylon, and Calodendron are found, sometimes in fair numbers. Pittosporum viridiflorum and Scolopia spp. are local.	Varies with the Moisture type.	Varies with the Moisture type. Best represented are the Lower layers of the *Dry* and *Medium* types. In addition the following are common:— Haemanthus puniceus, and Hypoestes aristata, and on opener sites, the large shrub Osteospermum moniliferum is abundant and well grown.	On sites exposed to the sea wind the height-growth is much shorter and the diameter-growth much less than inland, type for type. The crowns are usually asymmetrical owing to the influences of the winds, and they are much draped in Usnea barbata. On less exposed sites there is a general increase in height and diameter, type for type, but in general the dimensions are below those holding further inland. The timber is good except on the more exposed sites. REGENERATION VARIES MUCH WITH MOISTURE TYPE, BUT ON THE WHOLE IS SPARSE COMPARED WITH INLAND FORESTS.

NOTE TO TABULAR STATEMENT.

Coast **type Forest is distinguished by its close proximity to the sea and the shorter height growth of the tree species, Moisture type for Moisture type, but portions of the** ***Moist*** **type in well-protected positions differ but little in height growth as compared with the same type inland; the** ***Dry*** **and** ***Medium*** **types differ to a much greater degree.**

* *Vide* Philips, 1928; (6): 198–199.

Table XLII.

Type	Mean Holard at 18 Inches (dry-weight).	General Nature of the Soil.	Aspect Favoured.	General Position.	Floristic Features.				Nature of the Growth in the Upper Layers.
					Upper Layers.		Lower Layers.		
					Absent Typically.	Present Typically.	Absent Typically.	Present Typically.	
MONTANE. *	85–170 % as for the *Moist* type. In places up to 190 %	Usually heavy Clay-loam over Clay, or over rock. Humus abundant, and acid. PH 3·9–4·8.	S., S.W., S.E., rarely N. and N.W.	Deep secluded kloofs in the mountains, from 2,500–4,500 feet.	Most of the species of the mixed forests of the plateaux and foothills; notably Podocarpus elongata, Olinia, Plectronia obovata, Pterocelastrus, Myrsine (Apodytes in places may be frequent.)	Platylophus, Cunonia, are the most abundant, forming pure and mixed communities. In sites Ocotea occurs, along with Ilex. Large Virgilia occur on the sides at lower elevations; this species is much stunted at the higher.	Trichocladus and other shrubby layers. All shrubs and herbs of *Dry* and *Medium* types.	Dense Hemitelia, Marattia, Todea, Blechnum capense, under canopy. Sparmannia, Brachylaena heriifolia, Gleichenia polypodioides along the margins and in opener sites.	The rough climate of the upper altitudes produces a shorter height-growth, and a squat, asymmetrical form; the crowns are misshapen and gnarled. On the more exposed sites the mean height of the canopy does not exceed 10 feet. The general physiognomy of the vegetation resembles that of coastal Scrub and Bush; the canopy appears as an inclined plane, the most exposed portion being the lower edge of the plane. REGENERATION EXCEPT THAT OF CUNONIA, IS SPARSE OR ABSENT.

NOTE TO TABULAR STATEMENT.

Montane Forest is merely a habitat form of the *Moist* type. The Forests of this type are principally of value as *protection Forests*; the timber in them is of little value.

* *Vide* Phillips, 1928 (6): 199–200.

Chapter VIII.

SUMMARY OF SUCCESSION AND REACTION TENDENCIES.

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SUMMARY OF SUCCESSION AND REACTION TENDENCIES.

(a) Succession Tendencies.

A study of the development of vegetation within the Knysna region reveals the following features of interest and of importance :—

(1) The Temperate-form of Subtropical Forest and the Macchia or " Fijnbos " are the two formations within the region. Of these, the Forest formation is the more important in that it at one time must have been exceedingly more extensive than the Macchia, and in that the natural tendency is for it to develop or re-develop on ground held by the Macchia. Devastation by fire has diminished the area of the Forest formation very considerably.

(2) Forest is either the *actual** or the *potential* climax on all portions of the plateaux, the *potential* climax on the greater portion of the foothills of the barrier-range, and the *actual* climax in certain montane valleys. Macchia is sub-climax on the greater portion of the mountain slopes and the climax on the summits; it is also climax on small portions of the foothills. Owing to the agencies of fire and exploitation much land on the plateaux and foothills is bearing Macchia of *seral* nature: a stage in the succession to Forest.

(3) The important seres (Hydrosere, Lithosere, Psammosere) converge on Macchia or on Scrub.

(4) The Macchia is of three types: *Hygrophilous*, *Lithophilous*, *Psammophilous*. Any of the types may remain climax, and any of them may develop to Scrub, Bush, or Forest.†

(5) On account of fire, migration barriers (physical and biotic), reaction of vegetation, competition, and soil conditions, Macchia actually of seral nature, Scrub, and Bush may remain in *subclimax* condition.

(6) With reference to the Forest formation, the following *potential* climaxes, or *post-climaxes*, are indicated by a study of *mesoclines*‡ and *xeroclines*|| (Clements 1924: 75) and of vegetation zones and alternes in the region, and of vegetation zones exterior to the region :—

(*a*) Were the climatic conditions to become slightly drier, the drier type Forest would become climax; were the change toward drier conditions more marked, Bush would terminate the succession; were the change still greater, semi-karroid Scrub would take the place of Forest as the climatic climax.

(*b*) Were the climatic conditions to become slightly moister, Forest of more hygrophilous nature, composed largely of Platylophus, Cunonia, *Ilex mitis*, *Brachylaena neriifolia*,

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* *Actual*, i.e. *actually* existing in climax form.
Potential, i.e. having the power of developing to the climax—e.g. forest may not *actually* occur but the area may possess the *potential* for its production.

† According to the climatic and soil conditions.

‡ Moist, cool slope, regardless of exposition.

|| Dry, warm slope, regardless of exposition.

Sparmannia and Ferns, would form the climax; were the change in the direction of still greater humidity, luxuriant hygrophilous Macchia would form the climax in all probability.

(7) As the succession advances, the vegetation becomes richer in subtropical species of probable tropical ancestry. Bews (1920: 387-388) describes this condition for the coast belt of Natal, and formulates a "Law of Succession": "*In a subtropical region, as the succession advances, the vegetation becomes more and more tropical.*" It is interesting to note that in a region much nearer the temperate than Natal, a *temperate* flora—the South-western—yields ground to a *subtropical*, as the succession advances: Macchia is replaced by Forest.

(8) As the succession advances, the vegetation becomes less xerophytic: Macchia plants rich in ericoid forms yield place to slightly less xerophytic broad-leafed forms, and the latter to still less xerophytic, broad-leafed Forest forms.

(9) Bews (1920: 450) is of opinion that animal agencies (notably insects attacking seeds) may "*prove more potent than the climatic in leading to changes in the climax phase. In other words, the climax type of vegetation may change without any change in the climate.*"—At the Knysna, despite the careful study of the influence of animal and fungous pests, there is no evidence that biotic agencies can change the nature of the climax: at most they are responsible for originating subseral succession. Climate everywhere controls the climax, which is in equilibrium with it.*

(10) As held by Clements (1916: 145 et seq.) for vegetation in general, succession is found to be everywhere *progressive:* no instance of *regressive* succession, or so-called *degeneration*, has been detected. Disturbing agencies everywhere account for examples of seeming regression.

(11) In burn subseres an important role is played by *Virgilia capensis*, which is endemic to the coastal region commencing at the Cape Peninsula, and ending 20 miles West of Port Elizabeth, but as pointed out by Phillips (1926: 3) it is by no means the only pioneer. The hypothesis of Schönland (1924: 456-57) that were the species to disappear, the forests of the Knysna would automatically disappear, is not supported in fact.

(12) There are floristic and successional reasons for assuming that the Forest climax, so far from being a *decadent* one, is one filled with vitality and possessing great potential.

(13) Selective exploitation (*vide* Chapter 3: p. 103) of certain Forest tree species is producing appreciable changes in the *percentage frequency* of stems of Forest spp. The tendency is for Podocarpus spp., *Olea laurifolia* (which spp. do not coppice), and Apodytes (which coppices poorly) to be reduced in number, in contrast to other less-valuable timber spp., and such free-coppicing spp. as Ocotea, Curtisia, and Platylophus.

(*b*) Reaction Tendencies.

Reaction (Clements, 1904: 124; 1905: 256; 1916: 80-97) may be defined as *the effect of a plant or plant-community upon its habitat.*

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* See Phillips, 1930; (1) for an account of biotic communities in the Knysna region.

As the succession proceeds toward Forest, the principal reaction tendencies are as follows:—*

1. *Reactions on the Aerial Factors.*

1. *Reaction upon Light.*

All communities except the very earliest of the pioneer stages, reduce the light-intensity considerably. In all seres the tendency is toward increased reduction of light available to seedlings of the youngest stages, the lowest values (1/500-1/1500) being found under dense Macchia. On the Macchia yielding place to Virgilia communities, to Scrub, or to the *hygrophilous small tree and shrub stages* of the *Hydrosere*, the light-intensity at ground level is appreciably increased, the values ranging from 1/15 (Virgilia communities) to 1/500 (Scrub). The reasons for this increase are to be found in the disappearance of much of the dense under-growth of the Macchia consequent to its being shaded by the Virgilia and small tree stages, and in the opening up of the community as the result of the invasion by Scrub forms. Once the tree and Scrub stages develop to Bush or Forest, the intensity again decreases steadily on account of the formation of various layers. In ordinary high Forest the light values at ground level and at heights of from 20 to 50 feet, are low (*vide* Table XVIII, Chapter 2).

Altogether apart from unfavourable edaphic or biotic conditions prevailing in the community, the absence of regeneration in its various stages, or the poor growth of such regeneration as does exist, is to be attributed to insufficiency of light. Experiments in natural forest and under controlled field conditions alike show that degree of establishment would be considerably higher, and that rate of growth of the resultant seedlings would be many times faster, were better conditions of illumination available. At the present time the shade-tolerance of some seedlings of some spp. (e.g. *Olea laurifolia*, *Elaeodendron croceum*, Ocotea, Apodytes, and Podocarpus spp.) is remarkable. Some of the young plants put on absolutely no height or girth increment in the course of several years, and at the ages of 2 to 4 years are but several inches high, yet they continue to live. A decade later they may be several inches higher. From studies of the increments of young, of semi-adult, and of adult forest trees at the Knysna, it seems evident that one of the most potent causes of the slow rate of maturation in undisturbed primeval forest, is the inadequate light-supply available until such time as the trees have grown tall enough to pierce the canopy with their crowns. It is to be noted too, that even trees the crowns of which form the upper canopy of the forest, receive greatly diminished supplies of light owing to the close lateral packing. The poverty of herbaceous forms in Bush and Forest is a direct result of the low light intensity, these forms occurring on open sites and along the margins only.

The study of reaction upon light has already suggested various sylvicultural methods* likely to be useful in the management of the indigenous Forests, and the further study of this important subject is expected to return many data of scientific and practical value.

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* For a detailed summary of reaction data yielded by experiment, see Phillips, 1927 (6); 1927 (8).

† *Vide* Appendix 3 for a general account.

(2) *Reaction upon Humidity, Temperature, and Wind.*

Following Clements (1916:94.) the factors Humidity, temperature and wind are treated together for the reason that they are linked because of their influence upon transpiration, and upon evaporation of soil moisture.

Measurements of humidity, temperature (air, surface-soil, subsoil) and observation of wind, under several communities show that as the succession advances, each factor is separately reacted upon.

Thus there is a steady increase in humidity (i.e. a decrease in saturation deficit) in all communities (except the hydroseral, which for a period exhibits reduction in humidity as the sere advances, but later, an increase in common with the communities of the Psammosere and Lithosere), a steady decrease in temperature of air, surface-soil, subsoil, and a steady decrease in mean wind force. In consequence of these influences upon the single factors, the factor-complex formed by their integration, is also modified, the tendency being for the development of highly humid, cool, still conditions favouring reduced rates of transpiration and evaporation, under the canopy of the climax community. The dominants of that community naturally do not themselves fully participate in these optimum conditions, for their crowns are exposed, to some extent, to the rigours of the open atmosphere.

The most important periods in reaction upon the aerial factor-complex are, firstly that during which the pioneer stages first form a close cover over the soil, and secondly that in which Macchia is ousted by Scrub or Bush. The formation of layers within the Forest intensifies the reduction of humidity, temperature and wind, the moistest, coolest, stillest conditions prevailing just above the soil. In undisturbed Knysna Forest, owing to the large number of layers and the general continuity and closeness of such layers, interruptions in the general humidity, coolness and stillness are not met as the height above ground is increased. The conditions in British woodland, according to Salisbury (1925: 337-338) are different, on account of the comparatively even height development of ground flora, shrub layer, and tree layer over considerable areas, thus bringing about abrupt changes in aerial conditions according to height above ground. Adamson's (1912: 354) evaporation data: At level of the ground flora 142 c.c., immediately above the latter 176 c.c., in the shrub canopy 149 c.c., above the latter 182 c.c., support Salisbury's remarks. In typical Knysna Forest the evaporation curve shows a steady rise from below upward.

2. *Reaction on the Edaphic Factors.*

The material for an entirely new soil may be formed by pioneer hydroseral, lithoseral and haloseral communities, which materials later communities naturally considerably augment and modify. Thus hydroseral and haloseral communities form a semi-stable or stable substratum from free water surfaces, and the lithoseral a soil-covering for the originally bare rock surfaces. At the same time, existing soils are variously changed by plant reactions; thus the arid, unstable sands of the shore are firstly fixed, then given body by increased humus content, holard and chemical salts by the stages of the Psammosere; later stages of the Hydrosere continue to reduce the moisture content, and to add body to the substratum; later stages of the Halosere reduce the moisture content and salinity, and add body to the soil they occupy; finally later stages of the Lithosere increase the depth, holard, humus and salt content of the poor soil covering produced by the pioneer communities.

The reactions by which the new soil is formed or the original soil is modified, are:—

(*a*) *The accumulation of plant remains* almost entirely under either salt or fresh water, the remains being those of members of haloseral and hydroseral communities; added to these plant remains is much aeolian and water-borne material accumulated as a result of interception by the plant communities. The formation of a fair proportion of the soils of the plateaux, and of low-lying areas near the coast, has been commenced in this manner. Extensive peat formations in Europe have been built up in this manner in the course of the ages.

(*b*) *Formation by plants of soil from rock.*—Plants actually decompose sheet rock, and in addition add to the number and the size of the cracks in the latter, through action of their roots and stems. Cyanophyceae, Bryophyta, Lichens and chomophytes commence the operation, and are relatively soon assisted by Lithophilous Macchia plants and by pioneer Scrub shrubs.

(*c*) *Collection of aeolian and alluvial sand and finer particles* principally by early stages of the Psammosere and Hydrosere respectively, while gravel slides are arrested by pioneers of the Lithosere, especially along the faces of the barrier-range.

(*d*) *Addition of organic matter* resulting from the decomposition of the bodies of whole plants, and of foliage, twigs and fruits cast by plants. The main actions of humus are to lighten heavy soils by improving the porosity, and to give body to light soils. The holard capacity is decreased in the first type, and increased in the second. The general tendency, however, is for the holard to incease as the humus content increases, *the total available water content* (chresard) naturally does not increase in direct relation with the humus increment. The tendency is for the percentage of humus to increase as the succession progresses in all series, except the Hydrosere. In this sere the humus content increases to a stage (e.g. the Platylophus communities) and thereafter it decreases somewhat.

There is little doubt that in certain communities (e.g. the Platylophus consocies) the continued addition of humus to the soil supporting them, is detrimental to their own regeneration.

(*e*) *Indirect increase of water content of soil.*—As pointed out by Clements (1916: 88), there appears no case in which plants, apart from Sphagnum, increase the water content of a soil as a *direct* reaction, but their *indirect* influence in this direction is of fundamental importance. The increase of water content is brought about through the addition of humus accompanied by decreased rates of evaporation, run-off, and seepage. The tendency is for the available moisture to increase as the succession progresses. Occasionally, examples are found where the available water actually decreases as the succession advances, for the reason that addition of humus and decreased losses due to evaporation, run-off and seepage, have produced super-saturated moisture conditions in the soil. Thus the dense *Hemitelia capensis* layers in moist Forest, in the course of time, bring about such a state. Removal of the ferns results in a drop in holard and an increase in chresard.

(*f*) *Decrease of water content of soil.*—In exceedingly closely-stocked Forest, it is found that during dry periods the holard may be very considerably reduced, indeed to such an extent that young regeneration may disappear entirely. In the drier types of climax Forest rich in *Olea laurifolia* and in layers of the moisture-filching *Trichocladus crinitus*, the latter plant although almost completely protected by the canopy of the trees, uses up such considerable quantities of water that it not only precludes successful growth of tree seedlings, but in periods of drought, actually dies back itself, owing to decreased holard conditions.

The action of some of the large trees (e.g. Podocarpus spp. and *Olea laurifolia*) is to drain the upper 6-12 inches of soil of most of its moisture, in dry periods. The part played by the exotic *Acacia melanoxylon* in this connection, is described in Appendix II.*

(*g*) *Prevention or limitation of processes of soil denudation and desiccation.*—Plant covering limits or prevents denudation by water, and wind, leaching out of highly soluble solutes, the dispersal of fine particles by wind, and the loss of organic matter. In addition the moisture content is usually conserved, and the soil organisms are protected. Removal of the cover results in general deterioration of physical, chemical, and biotic qualities of the soil, unless unduly close conditions of stocking (e.g. moist high Forest rich in ferns; the Platylophus communities; dense Macchia) exist. Owing to the nature of the soil and the high rainfall experienced in the region, losses through denudation and desiccation are extremely high wherever the plant covering is removed through excessive grazing, careless agriculture, and severe burning.

(*h*) *Improvement of the aeration and texture* of harder and heavier soils of the region, is brought about by ramification through them of roots and rootlets of plants, more particularly of shrubs and trees. On the other hand, pure, loose sand and sandy soils *are bound into more homogeneous states* through the arresting action of roots and rootlets of pioneers communities of the Psammosere coastal and inland.

(*i*) *Addition of nutrients.*—Large quantities of mineral salts are returned to the soil as a result of fall of foliage and other plant parts, and the decomposition of dead plants. The use of solutes by the plants, on the other hand, sets up a constant drain upon the supplies available. Judging from the results of determinations of total available soluble salts, of soils from pioneer, medial and climax communities in the same sere, there is a *very slight increase* in soluble food materials as the succession progresses toward Forest.

(*j*) *Changes in Hydrogen-ion concentration of the soil solution.*—The details of change vary with soil type and with sere. Owing to the accumulation of organic matter, the acidity increases in the

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*** See Phillips 1928 (1).**

Psammosere and the Lithosere, until the Macchia stages are reached, after which there is a steady decrease as Forest develops. In the Hydrosere, examples of increasing acidity from the commencement of the sere are known to occur; on the other hand, after the initial stages, the reaction is usually in the direction of decreased acidity. The subject of pH values is referred to in Chapter I (pp. 28-32).

(*k*) *Soil organisms in symbiosis with certain plants.*—Organisms living in symbiosis with the roots of plants have a direct reaction upon the soil. At the Knysna, for example, in the Macchia the well-represented Leguminosae, containing the various strains of *Pseudomonas radicicola* in their root-nodules, materially influence the production of nitrogen. In the Forests, a strain of the same organism occurs on the roots of Podocarpus spp.: Two important species. (*Vide* Chapter 1, p. 33.)

From the above summary of reaction tendencies at the Knysna, it is readily seen that the vegetation of Macchia and Forest has had, and is continuing to have, an influence far-reaching and important, upon the climate and soils of the region.

Chapter IX.

GROWTH-FORM CHARACTERISTICS

and

RATE OF GROWTH OF THE MORE IMPORTANT SPECIES OF TREES.

Chapter IX.

GROWTH-FORM CHARACTERISTICS, AND RATE OF GROWTH OF THE MORE-IMPORTANT SPECIES OF TREES.

(*a*) Growth-form Characteristics.

Several of the characteristics—nature of foliage, occurrence of spines, thickness of bark, and development of coppice shoots—of South African Forest trees have been referred to by Bews (1925: 56-61). It is desirable, however, to describe these characteristics so far as the Knysna Forests are concerned, and in addition to deal with other important features hitherto undescribed, the principal of which is that of root-shape and root-depth.

1. *Average dimensions of the principal Forest species.*

The average maximum heights attained by the species are as follows:—

Layer.	Average Maximum Heights in Feet. (Top of Crowns.)	Species.
1	100–120 (trees 140 feet full height are known)	Podocarpus elongata L'Herit.
2	60–90	Podocarpus Thunbergii Hook.
3	50–70	Olea laurifolia. Ocotea bullata. Apodytes dimidiata. Ilex (capensis) mitis. Ekebergia capensis. Pterocelastrus variabilis. Myrsine melanophleos. Olinia cymosa. Curtisia faginea. Kiggelaria africana (rarely). Faurea McNaughtonii.
4	30–50	Elaeodendron croceum. Nuxia floribunda. Calodendron capense. Plectronia obovata. Plectronia Mundtii. Celastrus acuminatus. C. peduncularis. Royena lucida. Gonioma Kamassi. Olea capensis. Olea foveolata. Rhus laevigata. Cussonai umbellifera. Virgilia capensis. Fagara Davyi. Pygeum africanum.

Layer.	Average Maximum Height in Feet. (Top of Crown.)	Species.
5	Under 30	Toddalia lanceolata.* Celtis rhamnifolia. Lachnostylis capensis. Halleria lucida. Chilianthus arboreus. Tarchonanthus camphoratus. Ochna arborea. Gardenia Rothmannia. Burchellia capensis. Brachylaena dentata. Pittosporum viridiflorum. Ficus capensis. Royena pallens (forest form). Sideroxylon inerme. Elaeodendron Kraussianum. Scolopia Mundtii. S. Zeyheri.
6	Under 20, over 8	Trichocladus crinitus. Trichocladus ellipticus. Celastrus buxifolius. Rhamnus prinoides. Polygala myrtifolia. Osteospermum moniliferum. Brachylaena neriifolia. Fagara capensis. Euclea macrophylla. Doryalis (Dovyalis) spp. Psychotria capensis. Clausena inaequalis. Hippobromus alata. Plectronia ventosa. Ochna atropurpurea. Rhus lucida and spp.

* Toddalia = Vepris lanceolata G. Don.

(Stems of Hemitelia 10 feet in height are very abundant in moist Forest.)

The average maximum girths attained by the species are as follows:—

Class.	Average Maximum Girths in Feet. (At 4½ Feet above Ground.)	Species.
1	15–25	Podocarpus elongata L'Herit. Exceptionally large stumps of Ocotea and Platylophus are to be listed in this girth-class; such stumps are usually of short length and are grotesque in shape.
2	6–10	Ocotea bullata. Platylophus trifoliatus. Faurea McNaughtonii.
3	6–8	Olea laurifolia. Apodytes dimidiata. Ilex (capensis) mitis. Olinia cymosa. Cunonia capensis. Podocarpus Thunbergii.
4	4–6	Pterocelastrus variabilis. Nuxia floribunda. Plectronia obovata. Ekebergia capensis. Cussiona umbellifera. Curtisia faginea.

Class.	Average Maximum Girths in Feet. (At 4½ Feet above Ground.)	Species
5	2½–4	Plectronia Mundtii. Celastrus acuminatus. C. peduncularis. Elaeodendron croceum. Kiggelaria africana. Scolopia Mundtii. S. Zeyheri. Calodendron capense. Sideroxylon inerme. Pygeum africanum. Toddalia lanceolata.
6	Under 2½ feet and over 1½.	Celtis rhamnifolia. Lachnostylis capensis. Halleria lucida. Chilianthus arboreus. Tarchonanthus camphoratus. Ochna arborea. Gardenia Rothmannia. Burchellia capensis. Brachylaena dentata. Pittosporum viridiflorum. Ficus capensis. Royena pallens. Elaeodendron Kraussianum.
7	From several inches to 1½ feet	Trichocladus crinitus. Trichocladus ellipticus. Celastrus buxifolius. Rhamnus prinoides. Polygala myrtifolia. Osteospermum moniliferum. Brachylaena neriifolia. Fagara capensis. Euclea macrophylla. Doryalis spp. Psychotria capensis. Clausena inaequalis. Hippobromus alata. Plectronia ventosa. Ochna atropurpurea. Rhus lucida and spp. Hemitelia capensis stems.

2. *Nature of the boles and crowns.*

The growth-forms of the more important trees are few: (i) the clean and upright boled, simple-leafed type, with high-set crowns, e.g., Apodytes dimidiata, Ilex mitis, Kiggelaria africana; (ii) the slightly-inclined boled, heavily branched type, with or without simple leaves, e.g. Cunonia capensis and Platylophus trifoliatus (compound leaves), Elaeodendron croceum, Nuxia floribunda (simple leaves); (iii) the *gourmand-coppice* type: naturally-produced coppice surrounding a living or a dead central bole; e.g. Ocotea bullata.

These are all primitive types, but probably are not as primitive as that class of single-boled, large, and simple-leafed, sparingly-branched hygrophilous trees (e.g. Xymalos monospera, Bridelia micrantha, Macaranga capensis.) described by Bews. (1925: 49, 58, 84.)

The sole representative of this class at the Knysna is Ficus capensis, which in most instances does not form a tree of the class defined, but is a badly-shaped, heavily branched tree or a scandent shrub.

Characteristic features of the boles and crowns are discussed below:—

(*a*) *Plank buttresses* (Schimper, A. F. W.: 1903: 304-305).—Plank buttresses, or plank-like, or laterally-flattened outgrowths of the base of the trunk and of the uppermost roots, are described by Schimper. (loc. cit.) He considers the plank-buttress as a peculiarity of trees in a tropical climate with abundant rainfall.

While the plank-buttresses shown by several species at the Knysna are by no means as marked as the structures shown by species of Sterculia, Vitex, Bombax, etc., in the tropics, they are sufficiently well defined to attract attention. The species exhibiting the structures, at the Knysna, are to be divided into two classes:—

Species exhibiting marked plank-buttresses—

Ficus capensis.
Ilex capensis.
Calodendron capense.
Pterocelastrus variabilis (very well defined).
Elaedendron Kraussianum.
Plectronia Mundtii.
Plectronia obovata (at times very well defined).

Species exhibiting vestigial plank-buttresses.—

Apodytes dimidiata (at times).
Ocotea bullata.
Olea laurifolia (fairy well defined at times).
Gonioma Kamassi (at times).
Faurea McNaughtonii (at times).
Ekebergia capensis (at times).

It is interesting to notice that these trees showing buttresses belong to several important families better represented in the tropics of Africa: Moraceae, Aquifoliaceae, Rutaceae, Celastraceae, Rubiaceae, Icacinaceae, Lauraceae, Oleaceae, Apocynaceae, and Proteaceae. The exhibition of buttresses marks these plants as being of probable tropical ancestry.

(*b*) *Thickness of bark*.—As pointed out by Bews (1925:61) the possession of a thick bark is a feature of a number of South African Forest trees. The more important species occurring at the Knysna may be classified as follows, with respect to thickness of bark:—

Class.	Nature of the Bark.	Species.
1	Very thick; in many instances over ¾ inch.	Olea laurifolia. Olea foveolata. Olea capensis. Faurea McNaughtonii. Olinia cymosa. Curtisia faginea (older trees). Lachnostylis capensis (older trees). Sideroxylon inerme. Pterocelastrus variabilis. Some old Podocarpus Thunbergii Hk. and old Ocotea.
2	Thick; about ½ inch..........	Apodytes dimidiata. Ilex mitis. Podocarpus spp.* Ocotea bullata. Platylophus trifoliatus. Cunonia capensis. Nuxia floribunda. Scolopia spp.

* Young Podocarpus Thunbergii Hook and medium-sized P. elongata L. Herit often have "medium" bark

Class	Nature of the Bark.	Species.
3	Medium; about ⅓ inch........	Plectronia Mundtii. Plectronia obovata. Celastrus acuminatus. C. peduncularis. Elaeodendron spp. Tarchonanthus camphoratus. Pygeum africanum. Ekebergia capensis. Kiggelaria africana. Toddalia lanceolata. Calodendron capense. Celtis rhamnifolia. Gardenia Rothmannia. Halleria lucida. Burchellia capensis. Brachylaena dentata. Pittosporum viridiflorum. Ficus capensis. Royena lucida. Virgilia capensis.
4	Thin; less than ¼ inch; outer bark flaking off, several times per year	Ochna arborea. Ochna atropurpurea.

(*c*) *Production of spines.*—Spines are not developed to any great extent, and this is to be understood on account of the general moistness of the region.

A point of significance is that drier types of Forest, littoral Forest, littoral Bush and Scrub, and inland Scrub, are infinitely richer in thorny individuals and rather richer in thorny species, than are the medium-moist and the moist Forests.

Spines are exhibited by the following Forest forms:—Fagara Davyi, F, capensis; Scolopia Zeyheri, and at times S. Mundtii, especially on coppice; Plectronia ventosa, Celastrus buxifolius, C. nemorosus, Cassinopsis capensis, Carissa arduina, Scutia indica, Capparis citrifolia, Niebuhria pedunculosa (at times), Rubus pinnatus, Davyalis rhamnoides and Asparagus spp.

(*d*) *Cauliflory.*—The production of flowers and fruits from the old wood of branches and stems is rare, the only species exhibiting it being Halleria lucida, Ficus capensis, and Ficus Burtt-Davyi. Halleria lucida is of interest in that flowers arising from one and the same portion of the wood of the same tree, in different seasons, may be of different colours: brick-red, white, or creamish. The development of the dormant auxillary buds that burst through the cortex, and form the clusters of flowers, is studied readily in this species.

Cauliflory is a not uncommon feature of tropical Forest, and it is a little surprising to find that it is not better exhibited in the humid Knysna forests.

(*e*) *The production of Coppice shoots and of natural Layers.*—Coppice-producing species are numerous, and fortunately so, for the capacity of these species for reasserting themselves after being felled or burned, has had a great deal to do with the preservation of the Forest limits. Freely-coppicing forms are as follows:—

Ocotea bullata, Cunonia capensis, Platylophus trifoliatus, Apodytes dimidiata (often do not form good boles), Curtisia faginea, Gonioma Kamassi, Olinia cymosa, Ilex mitis, Nuxia floribunda, Kiggelaria africana, Scolopia Mundtii, S. Zeyheri, Royena lucida, Myrsine melanophleos, Halleria lucida, Plectronia spp., Burchellia capensis, Rhus laevigata, Celtis rhamnifolia, Lachnostylis capensis, Tarchonanthus capensis, Ochna arborea, Faurea McNaughtonii, Vepris (Toddalia) lanceolata, and Ekebergia capensis.

The rate of growth (in height and in girth alike) of coppice is appreciably greater than that of normally rooted stems, species for species. The coppice shoots flower and fruit normally. Coppice springing from portions of the stem more than 6 to 8 feet above the ground are frequently dislodged by strong wind, but those nearer the soil within several years form their own roots from dormant buds, and on the death of the parent stem, find themselves as independent individuals. It is fortunate that such valuable timber species as Ocotea bullata (Stinkwood), and Platylophus trifoliatus (Witte Els), which produce relatively few viable germules (*vide* Appendix I) produce fast-growing, vigorous coppice.

The natural production of *layers*, that is of procumbent branches that strike root and form additional stems as time goes on, is not common. The species forming layers are:—Platylophus trifoliatus, Cunonia capensis, and sometimes Ilex mitis; Gonioma Kamassi principally propagates itself by means of *layers*.

(*f*) *Crown types*.—The crowns of the more important species may be classified in the following manner:—

Crown Type.	Species.
Crowns conical in sapling and pole stages	All species.
Crowns conical in adult stages............	Pterocelastrus variabilis; Plectronia Mundtii; sometimes P. Thunbergii; Gardenia Rothmannia.
Crowns conical in semi-adult stages........	Ocotea bullata; Podocarpus Thunbergii Hook; P. elongata L'Herit.
Crowns egg-shaped (point downward) in adult stages	Podocarpus Thunbergii.
Crowns umbrella-like or umbelliform.......	Cussonia umbellifera.
Crowns springing from semi-decumbent or strongly inclined boles; crowns variously shaped	Nuxia floribunda; Platylophus trifoliatus; Elaeodendron croceum.
Crowns inverted broom-shape, horizontally extended, with strong branches	Olea laurifolia, O. capensis, O. foveolata; Ocotea bullata (adult stage); Apodytes dimidiata; Ilex mitis; Ekebergia capensis; Myrsine melanophleos; Olinia cymosa; Curtisia faginea; Kiggelaria africana; Faurea McNaughtonii; Caledondron capensi; Plectronia obovata; Celastrus acuminatus; Celastrus peduncularis; Royena lucida; Gonioma Kamassi (adult stage; conical in semi-adult stages); Rhus laevigata; Virgilia capensis (adult stage only); Fagara Davyi; Pygeum africanum; Toddalia lanceolata; Celtis rhamnifolia; Lachnostylis capensis; Halleria lucida; Tarchonanthus camphoratus; Ochna arborea; Sideroxylon inerme; Scolopia spp.

3. *Nature of the foliage.*

Practically all the species at the Knysna are *ever-green*, the same leaves remaining in position for periods of several years. (Marked leaves, freshly produced, have been kept under observation for several years at Deepwalls.) The leaves become more and more leathery with age, and assume abnormal shapes; they are much galled by Diptera and other insects, and are clad with minute Lichens.

Deciduous species occurring are Kiggelaria africana, Calodendron capense, Ekebergia capensis, Plectronia Mundtii, Ficus capensis, Rhus laevigata, Celtis rhamnifolia, and Heteromorpha arborescens, while in dry seasons Virgilia capensis may shed many of its leaves. Certain individuals of Clausena inaequalis and Hippobromus alata shed their leaves, while others retain them.

The species above listed do not systematically lose their foliage in the winter—they appear to be influenced more by the nature of the season than by the time of the year, thus in dry years they may lose all their leaves once or several times, while in abnormally moist years they may cast but portion of their foliage, or may remain fully foliaged for the entire year. The same species further East, in the Forests of Alexandria and the Amatola Mountains, are more regularly deciduous.

The leaves are in most instances simple, the exceptions being the trifoliate Rhus laevigata, R. lucida, several minor Rhus spp., Allophyllus erosus, A. decipiens Vepris (Toddalia) lanceolata, Platylophus trifoliatus, the 3-7-foliate Cussonia thyrsiflora, the 5-7-foliate Cussonia umbellifera, the variable Heteromorpha arborescens, and the pari—or impari—pinnate Fagara Davyi, F. capensis, Ekebergia capensis, Virgilia capensis, Schotia latifolia, Cassia tomentosa, C. occidentalis, Clausena inaequalis, Hippobromus alata, and Cunonia capensis. The proportion of species with compound leaves is thus a very small one. If there be a correlation between the humidity of the habitat and leaf division—and Bews's work with Bidens pilosa in this connection is suggestive and interesting (Bews and Aitken: 1925: 53)—it is readily understood why forms with divided leaves are rare at the Knysna, with its highly humid conditions of atmosphere and soil. Within the Knysna region it is noticeable that with the exception of Platylophus, Cunonia, and Virgilia, the divided-leafed forms are more numerous in the drier Forest types, and in Bush and Scrub, than they are in the moister types.

Macroscopic and microscopic study of the leaves of the principal tree species has revealed the following features of importance:—

The so-called *drip-tip form* is absent. *pubescent-coverings* are all but so (Trichocladus crinitus a shrub of the lower layers, and the trees Royena lucida and Curtisia faginea possess leaves villose on their ventral surfaces, while Buddleia salviaefolia, a rambling shrub of the margins, is protected on its ventral leaf surface by rusty pubescence), the smooth, glabrous forms prevailing.

Distinctly *varnished surfaces* do not occur, although there is an approach to the varnished condition in the upper surfaces of the leaves of Royena lucida and Rhamnus prinoides, and occasionally of Scolopia spp.

While the *cuticle* is fairly well developed on both surfaces, there are no forms with stomata sunk more than a very slight degree below the general level of the ventral surface. *Stomata* occur on the under surfaces of the leaves of all the Forest species; in Podocarpus elongata L'Herit, they occur on both dorsal and ventral surfoces. *No peculiar stomatal mechanism* has been observed. The development of *epidermal layers* is quite normal, there being slight traces of *hypoderm* in several species (e.g. in Cunonia, Platylophus and Ocotea) only. The *palisade* is usually 2-3 layered; no special water retaining cells are present; *crystal-sacs* are fairly well represented, oil vesicles less so. There is a strong development of sclerenchynatus *strengthening tissues* in the leaves of all the species. Anatomical details are given for some species (e.g. Olinia, Cunonia, Polygala myrtifolia, Olea capensis) by Knoblauch (1896) and for others (e.g. Ocotea, Gonioma, Olea spp., Curtisia, and Nuxia floribunda, etc.) by Gerhard (1902).

Experimental work at Deepwalls Research Station is showing the ready response made by the foliage of the more important Forest tree species [e.g. Ocotea, Platylophus, Cunonia, Curtisia, Olinia cymosa (Phillips, J. F.: 1925: (2): 211), Podocarpus spp., Faurea McNaughtonii, Virgilia capensis, Olea laurifolia, Apodytes dimidiata] to changes in prime aerial factors: Light-intensity, humidity, temperature. Indeed the structural response of the tissues of the leaves of several of the species above-mentioned is sufficiently delicate to encourage the writer with the hope that young plants of the species may be used as phytometers. Field observations show that the same species exhibits foliage differing in external appearance and dimensions, and in internal appearance and dimensions, according to nature of the habitat; species particularly interesting in this connection are Olea capensis, Apodytes dimidiata, Celastrus acuminatus, and Podocarpus elongata L'Herit. A systematic study of these habitat-forms or ecads is likely to lead far toward the solution of the problems of evolutionary history of South African Forest forms.

4. *Root depth and root form.*

A study of the root-systems of the Forest species of the Knysna has been made, utilizing as material the roots exposed in the processes of road-making in the Forests, and of exploitation. Special vertical quadrats or bisects, have been made from time to time. As no previous study of these important subjects has been made, the summary given below will be of particular interest to South African foresters and ecologists.

Owing possibly to the high rainfall and to the even distribution of that fall, the root-systems are remarkably shallow when the size of the trees is taken into consideration, and when the root depths of somewhat smaller European trees are remembered. The average maximum depth of penetration is $3\frac{1}{2}$ feet; exceptional penetrations of from 4 to 6 feet have been encountered, but these are rare.

The various species naturally differ as to the depth of penetration, and one species may penetrate deeper in one type of locality than it will in another. Depth of soil, nature of the substratum, aspect, degree of slope, and the nature of the Forest community are found to be factors that play important parts in deciding how far one and the same species may penetrate.

The species of importance may be classified according to depth of occurrence of the general root-system, in the following manner:—

Zone.	Description of Zone.	Species.
1.	The shallowest; from 12–18 inches	Olea laurifolia (the shallowest tree of large dimensions, in the Forest); Ficus capensis.
2.	Medium-shallow; from 18–24 inches.	Platylophus trifoliatus (has extensive laterals); Ilex mitis.
3.	Medium-deep; from 24–30 inches....	Podocarpus Thunbergii; P. elongata L'Herit. (has very extensive laterals of large dimensions; very large trees of this sp. have roots falling within Class 4) Nuxia floribunda; Cunonia capensis, Fagara Davyi; Virgilia capensis; Olinia cymosa; Kiggelaria africana; Scolopia spp.; Halleria lucida; Burchellia capensis; Ochna arborea; Royena lucida; Plectronia Mundtii; Faurea Mc Naughtonii. Gonioma Kamassi. Ekebergia capensis.
4.	Deepest from 30–42 inches..........	Apodytes dimidiata; Ocotea bullata; Plectronia obovata; Curtisia faginea; Celastrus acuminatus; Celastrus peduncularis; Pterocelastrus variabilis Elaeodendron croceum. *Very large* Podocarpus elongata L'Herit.

The form of root-system does not show very much variation, at the Knysna, but at the same time the species may be classified under several headings. A glance at European tree root-systems is helpful in describing the conditions at the Knysna. European species may be classified somewhat as follows:—*

Class.	Form of Root-system.	Examples.
1.	Flat, horizontal	Picea excelsa.
2.	Flat, with off-shoot roots decending like sinkers	Salix and Populus spp.; Betula and Alnus.
3.	Deep, heart-shaped roots, with long laterals	Ulmus, Acer pseudoplatanus; Tilia, Fraxinus.
4.	Tap roots persisting throughout life	Quercus, Castanea, Juglans
5.	Tap roots persisting for a time only, according to locality	Ulmus, Acer pseudoplatanus; Fraxinus.

While the Knysna species do not *exactly* fall into any of the above classes, they at the same time approach the types defined, to some degree.

Class 1 is not represented.

Class 2 includes Olea laurifolia, with the difference that the off-shoot roots do not descend vertically, but go off at angles of from 30-45 degrees. Ficus capensis, Ilex mitis, and Platylophus trifoliatus, too, fall under this description.

Class 3, with the modification that the long laterals are more extensively developed than they are in the European species, and that they leave the main heart-shaped root-mass at points nearer the surface, includes the following Knysna species:—

Adult forms of Podocarpus spp.; Nuxia floribunda; Cunonia capensis, Fagara davyi, Virgilia capensis, Olinia cymosa, Kiggelaria africana, Scolopia spp.; Halleria lucida, Burchellia capensis; Ochna arborea; Royena lucida; Plectronia mundtii; Plectronia obovata; Faurea McNaughtonii; Gonioma Kamassi, Ekebergia capensis.

* According to E. P. Stebbing.

Class 4 has no representatives apart from an occasional Ocotea bullata.

Class 5 has the following species:—

Apodytes dimidiata; Ocotea bullata; Curtisia faginea; Celastrus acuminatus; C. peducularis; Pterocelastrus variabilis; Elaeodendron croceum.

A detailed description of the nature of the smaller roots of the various spp. is not possible here, but they may be described in general as being strong, pliable, fibrous, and abundantly developed. Portions or forest examined have yielded as much as 1½-3 lb. dry-weight (oven-dried at 105 deg. Cent. to constant weight) of root-mass (no root over ¼-inch being included) per square metre, to a depth of 12 inches. This gives some impression of the dense development of the finer roots and rootlets.

(*b*) *Rates of Growth.*

The South African forest trees are considered *extremely slow-growing* by foresters, and the measurements of girth-increment taken in undisturbed forest or in long-rested, lightly felled forest, certainly support their view. It must be remembered, however, that temperate. tropical, and other subtropical forest trees, too, under primeval conditions of canopy and stocking, grow less fast than they do under sylvicultural management or in plantation form.

The Knysna species show better increment when the Forest in which they occur is systematically thinned and tended. At all events, the rotation required for the *commercial* maturation of the slowest even of the species, probably will not be as long as that adopted in the French Forests of Allier, for prime Oak: 280 to over 300 years.

1. *Girth Increment.*

The method of measurement of girth-increment adopted by the writer in the study of about 15,000 trees of various sizes from several inches in girth to over 60, is as follows (vide Plate 79):—

> A 1½-2-inch-wide band is carefully painted round the circumference of the bole, at about 4¼ feet above ground, after initial removal of old bark, lichens, etc. The lower edge of the band is made as even as possible by means of a sharp knife. The upper edge of a standard steel tape reading to 16ths of an inch is placed along this even edge, and the girth thus read. The tree is remeasured annually. Dendrographic studies are showing that the degree of error resulting from the reversible variation of the diameter of the bole and from expansion due to rising temperature, is beyond the limits of practical measurement, amounting to less than 1/10th of a millimetre in the largest trees.

The summary of girth-increments by girth-classes for a number of the more important trees, growing in Exploited Forest, in Exploited and Tended Forest, and in Natural Forest, given in *Table XLIII* is based upon data collected from 19 2-acre increment areas situated in various portions of the Knysna Forests. It is seen that as a general rule the increments are larger in Forest that has been opened up by exploitation than they are in normal Unexploited Forest, while those shown by opened-up and tended Forest are slightly greater than those for Forest exploited but not tended.

For sake of demonstrating the degree of growth taking place on a definite portion of Forest in one year, the annual increment shown by the several girth-classes of the main species occurring on an area of 2 acres, in Forest of medium holard, at Sourflats, is given in *Table XLIV*.

A summary of increment exhibited by certain species growing in Littoral Bush is given in *Table XXXII*, Chapter 5.

Dendrographic studies of diameter growth of several of the more important species by means of a MacDougal Dendrograph (MacDougal, D.T.: 1918; '19; '20; '21; '24; '25) have been commenced. The daily reversible variations described by MacDougal (op. cit.) are exhibited; the diameter being least during the driest, warmest period of the day, and greatest during the very early hours of the morning. Examples of Dendrograms for Olinia cymosa Thunb., and Ocotea bullata are given in Chapter II.

2. *Height Increment.*

The study of the height-increment of large trees by any exact means is practically impossible; several forms of auxanometer have been used by Continental foresters, but these are both unsatisfactory and expensive. The height-increment of small trees up to 30 feet, and of saplings and seedlings has been studied by means of ordinary direct measurement with light rods and rules, over 10,000 individuals being kept under observation in various portions of the Knysna region. The data available, however, are not considered sufficiently definite to warrant publication at this stage.

The examples given in *Tables XLV and XLVI* of low rate of height-increment exhibited by seedlings growing under dense canopy are of interest. The plants described in *Table XLV* were situated on a northern aspect, in a medium-moist Forest rich in Podocarpus Thunbergii, Olea laurifolia and layer of Trichocladus crinitus, those described in *Table XLVI* occurred on the southern aspect of the same hill, in moist Forest, and under cover of dense layers of Hemitelia capensis.

Table XLIII.

SUMMARY.—AVERAGE MEAN ANNUAL GIRTH INCREMENT PER 6-IN. GIRTH CLASSES: PODOCARPUS THUNBERGII HOOK.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I. *	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
		Inches.		Inches.		Inches.
3– 6...........	155	·093	17	·204	124	·067
7–12...........	157	·142	38	·187	130	·096
13–18...........	97	·188	37	·189	69	·118
19–24...........	87	·183	35	·321	55	·139
25–30...........	90	·202	30	·291	53	·141
31·36...........	72	·100	17	·241	29	·162
37–42...........	59	·223	8	·149	40	·143
43–48...........	38	·239	18	·259	23	·131
49–54...........	18	·284	5	·416	14	·240
55–60...........	10	·191	—	—	5	·162
61–66...........	2	·146	—	—	4	·222
67–72...........	1	·220	—	—	2	·131
73–78...........	1	·139	—	—	3	·168
79–84...........	—	—	—	—	1	·079
85–90...........	—	—	—	—	1	·098
Sums...........	787	—	205	—	553	—
Means...........	—	·187	—	·250	—	·139

* Average mean annual Girth increment.

Table XLIII.—(Continued).

PODOCARPUS ELONGATA, L'HERIT.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. ofTrees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I
Inches.						
3– 6...........	7	·128	—	—	—	—
7–12...........	4	·209	1	·174	6	·116
13–18...........	4	·368	1	·100	1	·042
19–24...........	4	·319	1	·225	—	—
25–30...........	4	·316	—	—	4	·317
31–36...........	2	·341	1	·037	4	·142
37–42...........	1	·750	—	—	2	·268
43–48...........	2	·531	1	·137	1	·196
49–54...........	2	·343	1	·187	1	·406
55–60...........	2	·290	1	·268	2	·093
61–66...........	—	—	—	—	1	·178
67–72...........	1	·299	1	·012	1	·197
73–78...........	—	—	—	—	—	—
79–84...........	—	—	—	—	—	—
85–90...........	—	—	—	—	—	—
Sums...........	33	—	8	—	23	—
Means...........	—	·354	—	·148	—	·195

Table XLIII.—(Continued).

OLEA LAURIFOLIA.

Girth Class.	Exploited Forest.		Exploited and Tendered Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I
3– 6...........	198	·091	10	·283	139	·070
7–12...........	267	·125	25	·247	198	·097
13–18...........	160	·196	19	·347	136	·158
19–24...........	106	·264	18	·361	65	·214
25–30...........	69	·290	22	·371	46	·204
31–36...........	63	·318	11	·539	34	·220
37–42...........	43	·272	8	·371	23	·214
43–48...........	13	·297	2	·287	18	·211
49–54...........	25	·362	4	·352	10	·253
55–60...........	7	·474	—	—	2	·256
61–66...........	2	·187	—	—	—	
67–72...........	2	·187	—	—	—	—
73–78...........	—	—	—	—	—	—
Sums...........	955	—	119	—	671	—
Means...........	—	·255	—	·350	—	·189

OLEA CAPENSIS.

3– 6...........	83	·072	—	—	61	·057
7–12...........	108	·151	—	—	95	·079
13–18...........	36	·152	—	—	36	·099
19–24...........	12	·167	—	—	9	·099
25–30...........	2	·156	—	—	3	·147
31–36...........	1	·125	—	—	—	—
Sums...........	242	—	—	—	204	—
Means...........	—	·137	—	—	—	·096

Table XLIII.—(Continued).

Apodytes dimidiata.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3– 6...........	157	·097	6	·263	175	·053
7–12...........	135	·133	14	·347	171	·111
13 18...........	63	·197	12	·324	89	·159
19–24...........	43	·198	5	·420	55	·174
25–30...........	21	·211	14	·299	34	·158
31–36...	16	·255	3	·218	22	·155
37–42.....	11	·253	—	—	8	·137
43–48...........	5	·226	1	·325	1	·100
49–54...........	2	·250	—	—	—	—
55–60...........	—	—	—	—	—	—
61–66...........	1	·187	—	—	—	—
Sums............	454	—	55	—	555	—
Means..........	—	·200	—	·313	—	·130

Table XLIII.—(Continued).

Ocotea bullata.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3– 6...........	132	·069	15	·227	—	—
7–12...........	64	·179	6	·243	66	·049
13–18...........	32	·216	6	·615	37	·223
19–24...........	31	·205	2	·487	14	·149
25–30...........	14	·243	2	·656	9	·081
31–36...........	13	·188	—	—	6	·122
37–42...........	6	·338	2	·506	3	·121
43–48...........	8	·181	2	·362	4	·176
49 54...........	—	—	—	—	4	·151
Sums............	300	—	35	—	143	—
Means..........	—	·202	—	·402	—	·134

Curtisia faginea.

3– 6...........	123	·116	7	·203	89	·076
7–12...........	103	·164	9	·283	73	·133
13–18...........	40	·201	3	·190	34	·199
19–24...........	35	·161	4	·347	17	·216
25–30...........	22	·253	7	·276	11	·225
31–36...........	9	·253	3	·412	7	·183
37–42...........	3	·267	—	—	8	·158
43–48...........	1	·220	—	—	2	·098
49–54...........	—	—	—	—	1	·087
55–60...........	—	—	—	—	1	·125
Sums............	336	—	33	—	243	—
Means..........	—	·217	—	·285	—	·150

Table XLIII.—(Continued).

PLATYLOPHUS TRIFOLIATUS.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3– 6...........	21	·180	—	—	5	·130
7–12...........	33	·163	—	—	20	·141
13–18...........	19	·219	—	—	5	·257
19–24...........	16	·191	—	—	6	·333
25–30...........	7	·315	—	—	2	·171
31–36...........	1	·108	—	—	2	·371
37–42...........	3	·119	—	—	2	·572
43–48...........	1	·423	—	—	—	—
Sums...........	101	—	—	—	42	—
Means...........	—	·214	—	—	—	·282

CUNONIA CAPENSIS.

Girth Class.	Exploited Forest. No. of Trees.	Exploited Forest. Av. M.A.G.I.	Exploited and Tended Forest. No. of Trees.	Exploited and Tended Forest. Av. M.A.G.I.	Natural Forest. No. of Trees.	Natural Forest. Av. M.A.G.I.
3– 6...........	—	—	—	—	4	·086
7–12...........	—	—	—	—	1	·187
13–18...........	—	—	—	—	4	·265
19–24...........	—	—	—	—	2	·096
25–30...........	—	—	—	—	1	·206
31–36...........	—	—	—	—	1	·275
37–42...........	—	—	—	—	—	—
43–48...........	—	—	—	—	1	·587
Sums...........	—	—	—	—	14	—
Means...........	—	—	—	—	—	·243

Table XLIII.—(Continued).

GONIOMA, KAMASSI.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3– 6...........	259	·093	—	—	231	·057
7–12...........	301	·098	—	—	206	·070
13–18...........	111	·078	—	—	102	·061
19–24...........	23	·063	—	—	23	·065
25–30...........	10	·120	—	—	6	·032
31–36...........	—	—	—	—	—	—
Sums...........	704	—	—	—	568	—
Means...........	—	·090	—	—	—	·057

PTEROCELASTRUS VARIABILIS.

Girth Class.	Exploited Forest. No. of Trees.	Exploited Forest. Av. M.A.G.I.	Exploited and Tended Forest. No. of Trees.	Exploited and Tended Forest. Av. M.A.G.I.	Natural Forest. No. of Trees.	Natural Forest. Av. M.A.G.I.
3– 6...........	177	·171	—	—	192	·119
7–12...........	191	·230	—	—	181	·180
13–18...........	61	·304	—	—	65	·236
19–24...........	37	·352	—	—	34	·247
25–30...........	25	·395	—	—	17	·255
31–36...........	11	·347	—	—	9	·312
37–42...........	8	·380	—	—	10	·342
43–48...........	1	·368	—	—	6	·163
49–54...........	1	·343	—	—	1	·037
55–60...........	—	—	—	—	1	·475
61–66...........	—	—	—	—	1	·231
Sums...........	512	—	—	—	517	—
Means...........	—	·321	—	—	—	·236

Table XLIII.—(Continued).

ELAEODENDRON SPP. (CROCEUM AND CAPENSE).

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3– 6...........	158	·083	6	·181	143	·061
7–12...........	111	·115	18	·244	95	·084
13–18...........	21	·150	5	·112	19	·135
19–24...........	3	·049	1	·086	7	·081
25–30...........	5	·089	1	·074	3	·182
31–36...........	5	·091	—	—	1	·236
37–42...........	—	—	—	—	—	—
43–48...........	—	—	—	—	1	·131
49–54...........	—	—	—	—	2	·105
Sums...........	303	—	31	—	271	—
Means...........	—	·096	—	·139	—	·126

CELASTRUS ACUMINATUS.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
3– 6...........	39	·120	—	—	25	·083
7–12...........	41	·146	—	—	23	·098
13–18...........	17	·171	—	—	14	·116
19–24...........	19	·234	—	—	5	·096
25–30...........	1	·312	—	—	1	·062
31–36...........	2	·156	—	—	—	—
Sums...........	119	—	—	—	68	—
Means...........	—	·189	—	—	—	·091

Table XLIII.—(Continued).

CELASTRUS PEDUNCULARIS.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.T.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3– 6...........	47	·100	—	—	26	·060
7–12...........	40	·108	—	—	46	·101
13–18...........	19	·191	—	—	15	·110
19–24...........	5	·218	—	—	5	·184
25–30...........	1	·218	—	—	2	·243
31–36...........	—	—	—	—	1	·427
37–42...........	1	·168	—	—	—	—
Sums...........	113	—	—	—	95	—
Means...........	—	·167	—	—	—	·187

MYRSINE MELANOPHLEOS.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.T.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
3– 6...........	4	·080	—	—	7	·098
7–12...........	4	·137	—	—	8	·311
13–18...........	3	·333	—	—	12	·231
19–24...........	2	·361	—	—	11	·217
25–30...........	1	·215	—	—	7	·300
31–36...........	—	—	—	—	5	·172
37–42...........	—	—	—	—	5	·229
43–48...........	—	—	—	—	4	·189
49–54...........	—	—	—	—	1	·145
Sums...........	14	—	—	—	60	—
Means...........	—	·225	—	—	—	·210

Table XLIII.—(Continued).

Ilex (capensis) mitis.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Ab. M.A.G.I.
Inches.						
3– 6...........	35	·032	—	—	15	·123
7–12...........	46	·298	—	—	32	·180
13–18...........	36	·291	—	—	13	·233
19–24...........	8	·333	—	—	10	·360
25–30...........	1	·306	—	—	7	·362
31–36...........	—	—	—	—	5	·375
37–42...........	—	—	—	—	1	·193
43–48...........	—	—	—	—	1	·400
49–54...........	—	—	—	—	—	—
Sums............	126	—	—	—	84	—
Means...........	—	·292	—	—	—	·279

Ochna arborea.

3– 6...........	24	·034	—	—	22	·032
7–12...........	24	·040	—	—	14	·041
13–18...........	2	·034	—	—	8	·035
19–24...........	—	—	—	—	3	·037
Sums............	50	—	—	—	47	—
Means...........	—	·036	—	—	—	·036

Table XLIII.—(Continued).

Olinia cymosa.

Girth Class.	Exploited Forest.		Exploited and Tended Forest.		Natural Forest.	
	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.	No. of Trees.	Av. M.A.G.I.
Inches.						
3– 6...........	12	·082	—	—	—	—
7–12...........	17	·234	—	—	4	·646
13–18...........	7	·391	—	—	—	—
19–24...........	6	·547	—	—	1	·606
25–30...........	3	·682	—	—	—	—
31–36...........	1	·787	—	—	—	—
37–42...........	1	·731	—	—	—	—
43–48...........	1	·493	—	—	—	—
49–54...........	3	·569	—	—	—	—
55–60...........	2	·444	—	—	—	—
Sums............	53	—	—	—	5	—
Means...........	—	·496	—	—	—	·626

Kiggelaria africana.

3– 6...........	6	·244	—	—	—	—
7–12...........	2	·303	—	—	—	—
13–18...........	1	·293	—	—	1	·131
Sums............	9	—	—	—	1	—
Means...........	—	·280	—	—	—	·131

Table XLIV.

ANNUAL GIRTH INCREMENTS SHOWN BY THE 16 MAIN SPECIES OCCURRING ON 2 ACRES OF FOREST (MEDIUM HOLARD), SOURFLATS.

Girth Classes	Number of Trees Studied.	Species.	Period of Observation.	Girth Increment per Individual.
Inches.				Inches.
0– 6	6	Podocarpus Thunbergii, Hook.........	1924–5	·0729
7–12	10		,,	·1437
13–18	8		,,	·1797
19–24	6		,,	·2916
25–30	5		,,	·1875
31–36	1		,,	·3125
37–42	2		,,	·1562
43–48	6		,,	·2604
49–54	1		,,	·1250
0– 7	1	Podocarpus elongata, L'Herit..........	1924–5	·1250
0– 6	10	Olea laurifolia........................	1924–5	·0500
7–12	9		,,	·1666
13–18	9		,,	·2430
19–24	7		,,	·2500
25–30	6		,,	·1979
31–36	2		,,	·3437
37–42	1		,,	·1250
55–60	1		,,	·1875
0– 6	7	Apodytes dimidiata..................	1924–5	·1160
7–12	23		,,	·1875
13–18	19		,,	·2368
19–24	10		,,	·3687
25–30	4		,,	·4531
31–36	2		,,	·2812
37–42	1		,,	·1250
0– 6	4	Ocotea bullata........................	1924–5	·0781
13–18	8		,,	·1797
19–24	6		,,	·2395
25–30	2		,,	·2500
37–42	1		,,	·1875
43–48	2		,,	·2500
0– 6	3	Curtisia faginea.......................	1924–5	·1250
7–12	3		,,	·1458
13–18	2		,,	·3437
19–24	5		,,	·4000
13–18	1	Platylophus trifoliatus................	1924–25	·2500
25–30	1		,,	·3125
37–42	1		,,	·9375
49–54	1		,,	·5625
7–12	1	Cunonia capensis.....................	1924–5	·1250
19–24	2		,,	·1875
37–42	1		,,	·1250
55–60	1		,,	·6250
0– 6	2	Gonioma Kamassi....................	1924–5	·0625
7–12	9		,,	·1388
13–18	6		,,	·1458
0– 6	2	Pterocelastrus variabilis..............	1924–5	·1875
7–12	22		,,	·0909
13–18	12		,,	·1666
19–24	14		,,	·1428
25–30	5		,,	·1500
31–36	7		,,	·1799
37–42	1		,,	·3750
0– 6	2	Elaeodendron croceum and capense....	1924–5	·0312
13–18	2		,,	·1562
19–24	1		,,	·0625
7–12	3	Celastrus acuminatus.................	1924–5	·1458
13–18	5		,,	·1625
19–24	1		,,	·1250
7–12	2	Celastrus peduncularis................	1924–5	·0937
7–12	2	Ilex (capensis) mitis..................	1924–5	·0937
13–18	5		,,	·2125
13–18	3	Olinia cymosa........................	1924–5	·4375
31–36	1	Nuxia floribunda......................	1924–5	·2500

Table XLV.

EXAMPLE OF HEIGHT-INCREMENTS OF SEEDLINGS IN FOREST, RICH IN TRICHOCLADUS CRINITUS LAYERS: AVERAGE HOLARD = 45% DRY WEIGHT.

Species.	Heights.		Species.	Heights.	
	25|5|25.	23|6|26.		25|5|25.	23|6|26.
	Ins.	Ins.		Ins.	Ins.
Podocarpus Thunbergii Hook...	9	9	Podocarpus Thunbergii Hook.. (*contd.*)	18	21½
	7½	8		53	53
	6	7¼		30½	33¼
	49	49		55½	56¼
	11	11½		100½	102¾
	10½	11¼		10	12
	7½	8		32	43¼
	10½	11		61½	63½
	11	11¼		44½	47
	22½	24		39	46¾
	24½	26½		44½	45
	16½	16½		53	67
	24½	28½		96	99
	6½	6¾		28	32
	7½	8			
	25	25¼	Podocarpus elongata, L'Herit...	39	39
	9	9¾		100	100
	8½	8¾		12	12
	30½	31			
	14	14¼			
	13½	31½	Olea laurifolia.................	7½	7½
	20	21¼		20½	20¾
	9½	10		36	39¼
	9	9½		10	12¼
	9½	9¾			
	38	46	Ocotea Bullata...............	26½	26¾
	20½	21		15½	15¾
	17	17¾		21	28½
	27	27		54	54½
	33½	34¼		50	53¾
	5	5¼		17½	18½
	13½	13¾		18	20½
	53½	53½		20½	20¾
	19	19		41	44¼
	22	22½		7½	7½
	12	12½			
	23	27½	Apodytes dimidiata...........	5½	5¾
	31	36¼			
	26	29¼	Elaeodendron croceum.........	16	19½
	48½	53		31	34
	49	52		6½	8
	50	58			

Table XLVI.

EXAMPLE OF HEIGHT-INCREMENTS OF SEEDLINGS IN FOREST, RICH IN HEMITELIA CAPENSIS LAYERS: AVERAGE HOLARD 170% DRY WEIGHT.

Species.	Heights.		Species.	Heights.	
	25|5/25.	21|6|26.		25|5|25.	21|6|26.
	Ins.	Ins.		Ins.	Ins.
Podocarpus Thunbergii Hook...	5	5	Ocotea bullata................	8½	9¼
	9	9¼		4½	5¼
	7	7		11½	12¼
	4	4		5	5
	7	7		6	7
	5	5¾		6	6½
				20½	21
Podocarpus elongata, L'Herit...	6	6		7½	8
				13	13¾
Olea laurifolia................	6½	9¼		8	8½
				7½	8
Curtisia faginea...............	4	4¾		16½	17¾
	4½	4½		17½	18
				25	26
Apodytes dimidiata...........	4	6		5¼	5¼
	2½	2½			
Cunonia capensis..............	5½	6¾			
	30	31			

Chapter X.

THE FORMER EXTENT OF THE FORESTS

and

THE RESULTS OF DISTURBANCE.

Chapter X.

THE FORMER EXTENT OF THE FORESTS AND THE RESULTS OF DISTURBANCE.

(*a*) The Former Extent of the Forests.

A. F. W. Schimper's statement (*vide* R. Marloth: 1908: 207) concerning the interesting subject whether the Forests ever had been much more extensive than they are under present-day conditions, has already been referred to in Chapter III (p. 100)—it remains to state reasons why the writer is of the opinion that while the Forests were much more extensive in past centuries, it is unlikely that the whole area between the ocean and the upper mountain slopes ever bore Forests.

Schimper (loc. cit.) considers that areas of primitive Macchia existed near the Forests, and that these were increased by man at the expense of the adjacent Forests. Since 1922 very careful and fairly extensive study of much of the Macchia-clad ground near and far removed from the Forests has been made, numerous examinations of soil strata and of vegetation relicts therein being carried out. The results obtained are summarized below:—

(1) Areas of Macchia exist that show no sign of relicts of Forest nature in the soil strata. Such areas bear a shorter, less luxuriant type of Macchia (even where protected from fire, grazing, and other disturbance) than do the areas described below. This Macchia type appears to be climax in nature —it is the highest expression of the capacity of the habitat, and has not at any time been Forest. Upper mountain slopes, the whole of the summits of the range, portions of the foothills and certain limited lateritic portions of the plateaux fall into this type. So far as the production of exotic tree plantations is concerned, this type of Macchia is likely to produce less favourable results than the types described below.

(2) Extensive areas of Macchia exist, from the soil of which large numbers of Forest relicts have been taken, in the form of ancient, and often charred, roots and stems, and charred resinous matter.

Microscopic examination of these woody relicts has shown them to be of such species as compose the Forest to-day; particularly common are Ocotea bullata, Platylopus trifoliatus, and Olea laurifolia, probably on account of their excellent decay-resisting powers. The charred resinous matter apparently is of the same nature as the substances formed by Myrsine and Pterocelastrus. In addition to wood and resinous matter there are well defined, incinerated layers in the soil, at depths of from 12 to 18 inches; too deep to be the results of fire in the Macchia. The Macchia on the ground, wherever protected, grows tall, and shows the presence of Scrub, Bush, and Forest forms. The manner in which the areas of this type connect innumerable Forest patches (*vide* vegetation maps of the region) certainly supports the hypothesis that the Forests covered them in time past.

Judging from the appearance of most of the relicts and from the depth of these below the surface, the Forests to which they relate, must have disappeared from the ground many centuries before the European ever set foot in the region. Naturally some of the relicts belong to Forests that occupied the soil less than a century ago.

(3) Actual relict trees or small relict communities occur at distances of several miles from the Forests, in places where they receive protection from fire and other agencies of disturbance. The soil strata of the areas of Macchia linking up such relict patches, invariably show the presence of wood relicts.

Were it possible to preserve strictly the Macchia (and the scattered Scrub and Bush relicts mingled with the latter) occurring on areas akin to types (2) and (3) described above, steady re-afforestation would take place by process of succession.

The subtropical element in the region is evidently the assertive one, the temperate or south-western the retreating. The subtropical flora has progressed to the utmost south-western limit of the Cape Province, and in centuries past—if we are to believe the records of the old Dutch settlers and the present-day testimony of the vegetation itself—a Forest belt with but minor interruptions, extended from near the town of George to the Cape.

Owing to man's interference (*vide* Chapter III, Section on History of the Forests, pp. 99-104), the Forests have been considerably diminished, but if one views the possibilities broadly, one cannot fail to be impressed with the thought that granted protection, the Forests —and therefore the subtropical flora—would commence their work of recapturing much territory lost to them in ages past. The Forests are blessed with vast potential in the direction of extension of their bounds, and their flora in the production of new forms possesses great possibilities. There is very slender evidence that the climate of the region has changed materially in any of the efficient factors within the period separating the present from the Tertiary, or if need be, from the Cretaceous; accordingly there is no reason for suspecting that the Forests are out of equilibrium with their environment, and are *naturally* retreating.

(*b*) *The Results of Disturbance.*

The principal agencies of Forest disturbance are fire, exploitation, and grazing.

1. *Fire.**

The results of fire so far as diminution of area is concerned, have already been discussed, but it is necessary to touch upon the successional features following disturbance by that agency.

* For further details regarding the influences of fire upon Macchia and Forest, *vide* Phillips, 1930; (2).

Forest fires rarely originate within the Forests, but attack from the margins where the flames find ready fuel in the Macchia shrubs and debris. Two distinct types of fire are common, the *ground fire* and the *crown fire*.

(i) *The ground fire.*—The ground fire burns into the leaf litter, humus layer, and root-mass layer, and usually remains alive several weeks in dry weather, despite combat by man. The roots of the less deeply rooted species are generally severely burned, the trees dying several weeks after. All germules except those of more deeply buried Virgilia capensis, and all regeneration, are destroyed.

The roots and lowest portions of the boles of the deeper rooted species (*vide* p. 221, Chapter IX) often escape death, but lose their upper boles; they frequently coppice from the burnt stumps several months after the fire. Notable in this respect are Ocotea, Curtisia, Elaeodendron croceum.

The succession following such a ground fire usually is much as follows:—*

(1) Dense weed growth, principally Helichrysum petiolatum, H. foetidum, H. diffusum, H. parviflorum, H. felinum, Hippia frutescens, Bidens pilosa, Senecio glastifolius, S. umbellatus, S. nudifolium, Dicrocephala latifolia, Leontonyx squarrosa, Asclepias fruticosa (in extensive consocies), Solanum nigrum, Physalis pubescens, Rubus pinnatus, R. fruticosus, R. rigidus (the 3 species forming dense tangles), Plectranthus spp., Hypoestes verticillata (drier portions), Tetraria spp., Schoenoxiphium spp., Ficinia spp., seedlings of Cluytia spp., and other shrubs mentioned in (2) below, appear, and the stumps of trees commence to produce coppice.

The plants above recorded occur either in consocies or associes.

(2) A number of weak, woody shrubs appear, in consocies or associes; these build up a canopy 8 to 15 feet in height. The principal species of this stage are Psoralea spp. (especially P. pinnata, P. axillaris); Podalyria spp. (especially P. calyptrata, P. cunefolia); Crotalaria spp.,† Cluytia spp. (especially C. affinis and C. pulchella); Andrachne ovalis, Rhamnus prinoides, Polygala myrtifolia, P. spp., Erica canaliculata, E. speciosa, Berzelia intermedia, Brunia nodiflora, Metalasia muricata, Osteospermum moniliferum, C. corymbosum, Phylica spp., Sparmannia africana.‡ The rate of growth is fast, within 18 months the cover may be up to 10 feet in height.

Seedlings of Halleria lucida and Burchellia capensis may be present at this time but do not grow at the same rates as the other spp., if Virgilia capensis seedlings occur in stage (1), they will have formed a canopy over 10 feet high within 18 months.

(3) Virgilia capensis builds up a community with a general height of 20 to 30 feet; under cover of the Virgilia occur numerous seedlings, saplings and poles of Halleria lucida,

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* *Vide* Schematic Chart: Diagram XXVII.

† Especially Crotalaria purpurea.

‡ Passerina falcifolia.

Burchellia capensis, Royena lucida, Olea capensis, O. foveolata, Plectronia Mundtii, P. obovata, P. ventosa, Myrsine melanophleos, Kiggelaria africana, Ekebergia capensis, and often local patches of regeneration of Ocotea, Apodytes, Podocarpus spp. A certain number of relicts of stage (2) remains on opener portions of the area.

(4) The Virgilia gradually decays and disappears (10 to 25 years) after the fire, leaving the Halleria, Burchellia. Royena lucida, and other species mentioned above, to form such consocies and associes as they can. In this manner is Forest reconstructed.

(ii) *The crown fire.*—The crown fire does practically no harm to the soil, to the young trees, or to the roots of the dominants, the fire being confined to the canopy formed by the larger, drier trees. The fire leaps from crown to crown, producing stagheaded trees that may remain alive for many years, but never reproduce normal crowns. Such injured, dry topped individuals serve as tempting bait for the next holocaust.

Crown fires naturally are often associated with ground fires, for the falling arms may ignite the litter on the floor and thus produce a ground fire.

Where the canopy is much opened up through the destruction of the crowns of trees adjacent, the lower layers of the Forest are generally damaged or destroyed by the falling debris, and a subseral succession of the type described for the ground fire above, may be originated. On the other hand, if slight disturbance of the lower Forest layers be caused, no subseral succession is originated, the young trees forming the layers merely developing to take the place of the older ones damaged or destroyed.

Gleichenia polypodioides consocies on burnt sites.

An important community that takes possession of burnt Forest no matter what the nature of the fire, is the *Gleichenia polypodioides consocies.*

Gleichenia enters the burnt area together with the usual weedy flowering plants, but readily suppresses these within several months. Its rich, branching, extensive fronds creep for many yards, and wherever they obtain the least support, commence to climb upward. In a short time the entire area is covered with the fronds. In August-October of each year, fresh strata of fronds are produced, the older fronds remaining alive for several years, but finally drying; on drying they do not fall but remain in position. The wire-like stems remain alive for many years. In the course of from five to twenty years a dense mass of rhizome, stem, and frond is built up, this mass ranging from 6 to over 12 feet in depth. The portions composed of the first few years' fronds are gradually compacted into an inpenetrable mat through the weight of the vegetation above. This mat in time becomes from 6 to 12 inches in thickness, and is constantly increased in thickness through the reaction of the fern. No other species of plants can establish themselves in the consocies, for the seeds cannot reach the soil proper, and even were they to do so, they would be unable to establish plants in the dark and humid mass of vegetation.

The consocies is capable of holding the ground for many years—examples are known to the writer where areas destroyed by fire 30 to 70 years ago, still are held by most luxuriant communities of the fern, showing no signs of allowing invaders to enter the territory.

The fern is not only defensive of its territory but actually also offensive—small trees or large shrubs growing along the margins of the communities of Gleichenia, are within a few years be-decked with a picturesque drapery of fronds causing death of the foliage and ultimately disappearance of the trees or shrubs. Even trees of 20-30 feet in height are scaled, and either killed or much impaired by the engulfing wealth of fronds. Should it happen, however, that there be a few members oı coppicing species on the area that has been burned, and should these be of vigorous growth, the fern is finally shaded and in this manner ousted. The quick-growing shoots of Ocotea, Olinia, Platylophus, Gonioma, and Halleria, within a few months of the fire are several feet above the level of the fern. For some years the shade cast by these shoots is insufficient to react detrimentally upon the fern, but when these shoots have formed a canopy cutting down the light-intensity to 1/10-1/20 of full sunlight, the fern immediately commences to show lack of vigour; increased density of the canopy results in gradual death of the Gleichenia.

The writer has studied methods of destroying the ground-wasting fern. To the present the most satisfactory and economical method known is to slash down the fern, but to leave quite undisturbed the 6-12 inch mat of rhizome, then to dig small holes in this mat about 3 by 3 feet apart, in which holes seedlings of the fast-growing, insolation-hardy Virgilia are planted. Disturbance of the rhizome mat to any extent results in the appearance of rank weed growth.

Once slashed down, the fern rarely attempts to recapture lost ground.*

The community has been described by J. F. Phillips [1926 (3)] in connection with the dormancy of seeds of Virgilia capensis.

2. *Exploitation.*

The subject of the history of exploitation of the Forests has already been discussed (*vide* Chapter III, pp. 102-104), and it remains only to describe briefly the successional influences of this form of disturbance.

Exploitation has been responsible for the removal of varying degrees of the upper canopy and of the lower canopies. In most Forest owned privately the degree of removal has been very severe, the Forests under Forest Department control having received much better treatment.

The consequence of removal of the canopy to any appreciable extent has been the introduction of insolation factors detrimental to both aerial and edaphic factors of the Forest. Regeneration of the Forest trees and of the large woody shrubs, while fully capable of reconstructing the Forest on all sides of reasonable dimensions is either unable to do so, or finds great difficulty in doing so, on sites of more than 40 yards in diameter. Regeneration appearing on insolated sites soon after removal of the cover is lesioned, as described in Chapter II (pp. 39-96). Regeneration appearing after the weed

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* *December*, 1930: Areas cleared in 1923 remain fern-free.

communities have captured the sites is unable to develop, owing to the severe competition of these communities for moisture and room. Seeds reaching the sites after they have been captured by the weeds, are often unable to germinate owing to the absence of suitable moisture conditions; moreover many of them fail to reach the soil surface owing to the dense weed masses. Such seeds as do germinate under cover of the weeds fail to produce healthy seedlings, owing to the unfavourable light, humidity, and aeration factors. The weed communities, it is scarcely necessary to point out, are the direct results of allowing insolation factors to work upon the Forest floor.

The principal succession stages in exploited Forest are as follows:—

(1) Dense weed growth on heavily exploited sites principally Helichrysum petiolatum (which forms dense masses many yards in extent and from 2 to 10 feet in height, these masses pressing heavily upon the soil and cutting down the light-intensity to 1/300 to 1/600 that of full sunlight, at ground level, and removing much moisture from the upper soil layers); Helichrysum foetidum (which forms tall-growing, upright consocies many yards in extent); Bideas pilosa (which forms dense, usually upright consocies covering many yards); Hippia frutescens (forming semi-prostrate, dense, untidy consocies of considerable extent), Senecio glastifolius (forming upright, untidy consocies of very considerable density); Rubus fruticosus (introduced to the region in the early nineteenth century, now a troublesome weed); R. rigidus (forming extensive, impenetrable consocies); R. pinnatus (forming small consocies of moderate density); Cliffortia odorata (forming extensive consocies of great density); C. ferruginea; Polygonum sengalense (exotic—forming dense consocies in some Forests); Plectranthus fruticosus (forming very large consocies sometimes of great density, cutting down the light-intensity as low as 1/500); Verbena bonariensis (frequently in dense consocies); Cluytia pulchella, C. affinis, C. alaternoides (in seeding stages—in consicies and associes of great density, completely covering the ground); Physalis pubescens (in untidy consocies, sometimes dense); Solanum nigrum (very dense, untidy, semi-prostrate consocies); S. giganteum (forming tall, upright consocies which cut down the light-intensity greatly when they are dense); various Cyperaceae (chiefly Schoenoxiphium lanceum, Tetraria sp. nov.; Ficinia sylvatica, Ficinia capillifolia, Scirpus tenellus (very moist paths); S. prolifer (moist sites generally) Mariscus congestus (forming extensive consocies where soil is damp); Carex aethiopica (scattered throughout moist exploited sites); Juncus lomatophyllus (on damp sites only); Zantedeschia aethiopica (forming extensive and dense consocies where moist conditions prevail.

(2) Shoots of Halleria lucida, Royena lucida, Platylophus trifoliatus, Cunonia capensis, Gonioma Kamassi appear wherever trees of these spp. have been felled, the shoots

within several years attaining heights ranging from 6 to 18 feet, and casting a fair degree of shade. Mingled with these shoots are the following weak, woody shrubs, forming a canopy 8 to 12 feet in height within 18 months of exploitation:—Osteospermum moniliferum (principally in Forests nearer the coast); Cluytia pulchella (an important shrub of wide distribution); C. affinis; Adenocline mercurialis; Cassia tomentosa and C. occidentalis (large shrubs or small trees of fast growth, possibly exotic); Psoralea pinnata (forming very close consocies); Virgilia capensis (scattered, except where local fires have scorched the soil); Podalyria spp.; Crotalaria spp.; Polygala myrtifolia (forming tall and extensive consocies in some places); P. oppositifolia (forming short, dense consocies or mixed with P. myrtifolia); Rhamnus prinoides; Erica canaliculata (local, but dense where it does occur); Berzelia intermedia (forming dense consocies); Metalasia muricata (building very dense, tall consocies reacting strongly on the light). Passerina falcifolia is locally abundant, forming consocies to 10 feet in height.

(3) The Halleria shoots, which are frequently abundant on exploited sites, within 5-15 years, according to locality and type of Forest, attain heights ranging from 15 to 25 feet in height, and form a canopy which protects the plants below it from insolation, but which does not cut down the light too strongly.

Halleria is often assisted in this work of reconstruction by shoots of Royena lucida, Burchellia capensis, Platylophus, Ocotea, Curtisia, Gonioma. Under canopy of the shoots, the weak woody shrubs commence to thin out, and seedlings of desired Forest species appear, and grow fast. Within the space of another 5 to 10 years, the exploited site shows presence of saplings of Forest trees growing under cover of the now relatively large Halleria, Burchellia, and Gonioma shoots, and under the much higher shoots of Ocotea, Curtisia, and Platylophus.

On slightly exploited sites the weeds of stage (1) afore described, are few and non-rampant, the shrubs of stage (2) acting as the real pioneers of the subsere, and building up the canopy within a few years.

The following Raunkiär analysis of the ground vegetation existing on a portion on practically *clear-felled* Forest 4 years after removal of the Forest canopy, gives an impression of the species found on such sites, and of their relative abundance.

EXPERIMENTALLY CLEAR-FELLED FOREST, SOURFLATS.

Species Occurring. (No Plants over 15 Feet in Height Recorded.)	Number of 1-square metre circles on which they occurred, out of a possible 100.
Plectranthus fruticosus	58
Halleria lucida seedlings	56
Cluytia pulchella	38
Trichocladus crinitus shoots	34
Galopina circaeoides	26
Helichrisum petiolatum	26
Carex aethiopica	24
Schoenoxiphium lanceum	24
Curtisia faginea seedlings	20
Pteridium aquilinum	20
Blechnum punctulatum	20
Burchellia capensis seedlings	19
Hemitelia capensis shoots	16
Cluytia affinis	14
Nuxia floribunda seedlings	14
Trichocladus crinitus seedlings	14
Moraea iridioides	12
Oxalis sp. (no flowers)	12
Apodytes dimidiata shoots	10
Helichrysum parviflorum	10
Elaeodendron croceum shoots	10
Burchellia capensis shoots	8
Ocotea bullata shoots	8
Royena lucida seedlings	6
Halleria lucida shoots	6
Olea laurifolia seedlings	6
Cyperus tenellus	6
Helichrysum foetidum	6
Clematis Thunbergii	6
Erica canaliculata	6
Stoebe cinerea	6
Impatiens capensis	5
Cryptostemma calendulaceum	4
Asparagus sp.	4
Platylophus trifoliatus seedlings	4
Aristea pusilla	4
Podocarpus Thunbergii seedlings	4
Plectronia Mundtii seedlings	4
Aacacia melanoxylon seedlings (seeds introduced by birds)	4
Acacia melanoxylon shoots	2
Euryops virgineus	2
Rubus pinnatus	2
Rubus fruticosus	2
Ficinia capillifolia	2
Juncus capensis	2
Pellaea viridis	2
Rumex acetosella (introduced by cattle)	2
Athanasia muricata	2
Serpicula (Laurembergia) repens	2
Pterocelastrus variabilis shoots	2
Celastrus acuminatus seedlings	2
Zehneria scabra	2
Pyrenacantha scandens	2
Rhamnus prinoides	2
Gonioma Kamassi shoots	2
Wahlenbergia procumbens	2
Senecio sp. (no flowers)	2
Trimeria alnifolia seedlings	2
Secamone Alpini	2

A point of some importance with respect to exploitation of Forest is that the absence of natives from the region has preserved the seedlings and saplings from destruction. The Forests of the Eastern Province and of the Transkeian Territories, in most places, have been cleared of their young regeneration stages, the pliable saplings being used by the natives for hut-building purposes.

The subject of careful exploitation of Forest so that the state of the latter, so far from being depreciated, is actually improved, is discussed in Appendix 3.

Without entering into details concerning their structure, it is desirable to list the more important subseral communities that appear on exploited sites in various portions of the Forest:—

In Consocies.—

Psoralea pinnata.
Crotolaria purpurea.
Virgilia capensis.
Osteospermum moniliferum.
Osteospermum corymbosum.
Metalasia muricata.
Polygala myrtifolia.
Helichrysum petiolatum.
Halleria lucida.
Rhamnus prinoides.
Empleurum serrulatum.
Barosma scoparia.
Berzelia intermedia.
Plectranthus fruticosus.
Sparmannia africana.
Cassinopsis capensis.
Cluytia pulchella.
C. affinis.
Passerina falcifolia.*
Tangles of Scutia (indica) Commersonii, draping trees.
Tangles of Rhoicissus capensis, draping trees.
Tangles of Mikana capensis, draping trees.
Laurophyllus capensis (Botryceras laurinum).
The possibly exotic Cassia tomentosa and C. occidentalis.

In Associes.—

Two or more of the above species.
Particularly:—
Halleria lucida—other spp.
Virgilia capensis—other spp.
Cluytia pulchella—C. affinis.
Laurophyllus—other spp.
Osteospermum—other spp.

3. *Grazing.*

Owing to the absence of a native poulation, the Knysna Forests have escaped to a very large extent the evils of grazing by cattle, sheep, goats. In certain areas oxen have destroyed much of the younger regeneration, but such sites if protected, speedily produce young plants from seeds " walked " into the soil by the cattle. Forest much frequented by cattle, however, gradually opens up so far as the lower layers are concerned, for regeneration stages are prevented from developing and the woody shrubs are gradually eliminated (*vide* plate 50.) The Forests of the Eastern Province, owing to the large degree of grazing to which they have been subjected for generations, assume in parts a non-active aspect almost entirely absent at the Knysna.

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* P. filiformis in forests at Karatara and Farleigh, west of Knysna.

Appendix 1.

GENERAL BIOLOGY OF THE FLOWERS, FRUITS and YOUNG REGENERATION OF THE MORE IMPORTANT SPECIES OF THE KNYSNA FORESTS.*

(A SUMMARY OF PRELIMINARY STUDIES.)

[*Vide* Phillips, 1926; (4).]

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* 63 spp.

GENERAL BIOLOGY OF THE FLOWERS, FRUITS, AND YOUNG REGENERATION OF THE MORE IMPORTANT SPECIES OF THE KNYSNA FORESTS.

(A SUMMARY OF PRELIMINARY STUDIES.)

[*Vide* Phillips, 1926; (4).]

INTRODUCTORY REMARKS.

As practically no information concerning the biology of the flowers, fruits, and young regeneration of the more important South African forest trees and shrubs was available, the writer—under the direction of the Chief Conservator of Forests—in January, 1923, commenced collecting data relating to the subject. The principal objects of the investigation are the elucidation of the behaviour of the species with respect to seasons of flowering and fruiting, study of pollination phenomena, the collection of information regarding the nature, efficiency, dispersal, and germination of the seeds, and the study of the establishment and fate of young regeneration.

The aim of the present communication is to summarize the information at present available for about 63 species of trees and woody shrubs occurring at the Knysna. The nature of the communication precludes discussion of any but the salient features in the biology of the flowers, fruits, and regeneration of the various species.

METHODS.

The methods employed are essentially simple: the *monthly observation* of over 2,000 selected trees of the various species, for the sake of collection of *phenological* data; the study of the *structure* of flowers and fruits; *pollination experiments in Nature and under control*; observations and experiments connected with *dispersal* of fruits and seeds; nursery and quadrat *germination* experiments.

1. *Flowering and Fruiting Seasons.*

As has been pointed out by the writer (1926 " 1 ")* in another paper, the phenomena exhibited by certain Knysna trees with respect to flowering and fruiting seasons are not readily explicable.—Some species are most irregular as to flowering and fruiting seasons: trees of the same or of different species may flower every month in one year and not on a single occasion in the next; they may flower profusely at certain periods in one year, poorly at identical periods in the next, and not at all at the same time in the year following; there may be intervals of one year or of two, three, or more years between flowering periods—endless variation in behaviour is exhibited. Owing to the absence of a definite dry season—and indeed of a truly cold one—the species have little reason for reflecting the influences of the orthodox seasons.

Short spells of either abnormally moist or abnormally dry weather, abnormally warm or abnormally cool weather, together with local edaphic and topographic conditions, seem to be of more importance in deciding the periods of production of flowers and of fruits than does the mere following round of the seasons of the year.

* Citations given at end of Appendix I.

For the sake of eliminating so far as possible the complications introduced by the individual behaviour of trees of the same species it has been found essential to observe definitely marked trees and a sufficiently large number of these, frequently, and over a lengthy period.

The *behaviour* table (*Table* 1)† summarizes existing information concerning the seasons of flowering and fruiting of 63 species of trees and shrubs.

A feature of interest is the influence that proximity to the ocean has upon the date of general flowering and fruiting for all species dealt with in the Table. Individuals near the sea flower several weeks earlier than do those on the plateaux inland, whereas those on the plateaux flower and fruit several weeks to several months before their relatives in the mountain-kloof patches. Despite careful investigation and consideration, the reason for the definite gradation is not explicable. Temperature differences among the littoral, the plateaux, and the mountain-kloofs are very slight—averaging 3 degrees Fahr. between littoral and plateaux, and 5 degrees Fahr. between littoral and the mountain-kloofs, the littoral being the warmest of the three localities. The differences in relative humidity and rainfall are certainly more marked: the relative humidity on the littoral is 5-10 per cent. lower than that on the plateaux, and the mountain-kloofs experience a humidity 2 to 4 per cent. higher than the plateaux; the rainfall on the littoral is 10 to 15 inches lower than that experienced by the plateaux and 20 to 30 lower than that obtained by the mountain-kloof patches. The light intensity in the three types of locality, for all practical purposes, is the same. The slightly warmer and rather drier conditions holding at the littoral may possibly account for the earlier appearance of Autumn, Winter, and Early-Spring flowering blossoms, but in the opinion of the writer can scarcely be considered responsible for the earlier appearance of those blossoms opening in Summer.

There is a tendency for individuals of certain species, e.g. *Platylophus trifoliatus*, *Cunonia capensis*, *Nuxia floribunda*, *Chilianthus arboreus*, *Brachylaena neriifolia*, *Olea laurifolia*, and *Apodytes dimidiata* to flower slightly earlier as the West is approached *within the George-Knysna-Zitzikamma Forest region*. The reason for this behaviour is not clear, for in both Winter and Summer the temperature becomes slightly lower as one progresses Westward, while the rainfall scarcely alters.

Flowering is sometimes further advanced, species for species, on northern, north-western, and north-eastern aspects than on the cooler southern, south-western, and south-eastern.

Northern, north-western, and north-eastern sides of trees often show masses of flowers several weeks before these appear on the sides opposite. As has been described by the writer (1926: " 2 ") in the instance of *Virgilia capensis*, the reason for this phenomenon is to be found in the greater degree of light available on the northern, north-western, and north-eastern sides, and in the occurrence of a higher local temperature on these sides, more especially during the Winter months.

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† Tables given at end of Appendix I.

2. *Quantity and Efficiency of the Flowers.*

(*a*) *Quantity.*—In full flowering seasons the amount of flowers borne by the individual tree *varies according to proximity to the ocean, aspect, light-intensity, degree of soil-moisture, age and nature of the tree,* and naturally according to *species.* Trees near the ocean, on the whole, flower slightly more profusely than do those inland; trees on western, northern, north-western, and north-eastern aspects more profusely than those on eastern, southern, south-western, and south-eastern.

Marginal or isolated trees experiencing stronger light-intensity than those within the forests or under canopy, flower more abundantly than the latter. Trees occurring in the drier forests usually bear richer crops than those in moist forests, but considerable variation according to species, is found—thus *Podocarpus spp.*, *Elaeodendron spp.*, *Celastrus buxifolius*, Pterocelastrus, *Plectronia spp.*, Ekebergia, *Myrsine melanophleos*, *Trichocladus spp.*, *Ochna spp.*, *Olinia cymosa*, and Sideroxylon, flower best in the *drier forests*, whereas Cunonia, Platylophus, Nuxia, Sparmannia, and *Brachylaena neriifolia* flower best under *moist conditions*, while Ocotea, Halleria, Apodytes, Gonioma, *Trimeria alnifolia*, and *Olea laurifolia show the richest* flower crops under *medium-moist* conditions. Adult trees bear more heavily than large immature ones, and large, over-mature, often more heavily than mature. Diseased or otherwise damaged, and burnt individuals frequently bear heavier crops of flowers than normal ones.

The average, normal, adult individual growing under normal forest conditions, in full flowering seasons, bears flowers to the extent described below, *according to species:*—

(i) *Flowers very abundant*: (24 species, or 38.1% of the 63 spp. studied).

Podocarpus elongata L'Herit, *P. Thunbergii Hook*, *Olea laurifolia*, *O. capensis*, Ocotea Apodytes, Curtisia, Platylophus, Cunonia, Nuxia, *Chilianthus arboreus*, *Olinia cymosa*, Ilex, *Myrsine melanophleos*, *Faurea MacNaughtonii*, *Pterocelastrus variabilis*, *Celastrus buxifolius*, Halleria, *Plectronia obovata*, Sideroxylon, *Brachylaena neriifolia*, Tarchonanthus, Ekebergia, Rhamnus.

(ii) *Flowers abundant:* (20 species, or 31.8% of the 63 spp. studied).

Olea foveolata, *Cassinopsis capensis*, Kiggelaria, *Dovyalis rhamnoides*, Virgilia, *Acokanthera venenata*, *Elaeodendron croceum*, *E. capense*, *E. Kraussianum*, *Celastrus acuminatus*, *C. peduncularis*, *Plectronia Mundtii*, *P. ventosa*, *Royena lucida*, *Euclea macrophylla*, *E. lanceolata*, *E. racemosa*, *Rhus laevigata*, Lachnostylis, *Ficus capensis*.

(iii) *Flowers in moderate numbers:* (12 species, or 19% of the 63 spp. studied).

Widdringtonia cupressoides, *Trimeria alnifolia*, Calodendron, *Toddalia lanceolata*, *Fagara Davyi*, Burchellia, Sparmannia, *Trichocladus crinitus*, *T. ellipticus*, *Ochna arborea*, *O. atropurpurea*, *Celtis rhamnifolia*.

(iv) *Flowers few:* (5 species, or 7.9% of the 63 spp. studied).
Scolopia Mundtii, *S. Zeyheri*, Gonioma, Scutia, *Carissa arduina*.

(v) *Flowers very few:* (2 species, or 3.2% of the 63 spp. studied).
Gardenia Rothmannia, Pittosporum.

It is seen that about 70% of the species studied, bear flowers in some abundance. There are several factors that make it necessary that large numbers of flowers should be produced, the more important of these being as follows:—

(*a*) *Uncongenial atmospheric conditions:* dry, hot Foehn ("Berg") winds that shrivel the flowers; strong gales that toss thousands to the ground; heavy rains that beat the flowers to pieces; dry weather and high degree of insolation that kill buds and open blossoms alike, still, warm, humid weather that favours parasitic Fungi and Insects.

(*b*) *Biotic foes:* especially Aphids (*Olinia cymosa* suffers severely) and Psyllidae (Apodytes, *Olea laurifolia*, *O. capensis*, *O. foveolata*, are often attacked with severity) among Insects, and *Pestalozzia sp. nov.* (*Ocotea bullata*), *Capnodium spp.* (all species), and an unidentified fungus attacking the flowers of *Nuxia floribunda*. The birds *Zosterops capensis* and *Estrilda astrilda* often do considerable harm to flowers in their attempts to find Insects hidden in the latter.

(*c*) *The possibility of a dearth of pollinating agents:* in some years Honey Bees are less abundant than normal, this being due to disease and to nature of the weather. Nectariniidae are less numerous in some years than others, the causes being uncongenial weather during the brooding and hatching periods and scarcity of food.

Were small flower crops borne it is more than likely that the output of fruits by some of the tree and shrub species would be inadequate to account for the successful regeneration of their kind.

(*b*) *Efficiency.*—The degree of efficiency of the flowers with respect to fertilization, is described in the final column of *Table II*, species by species.

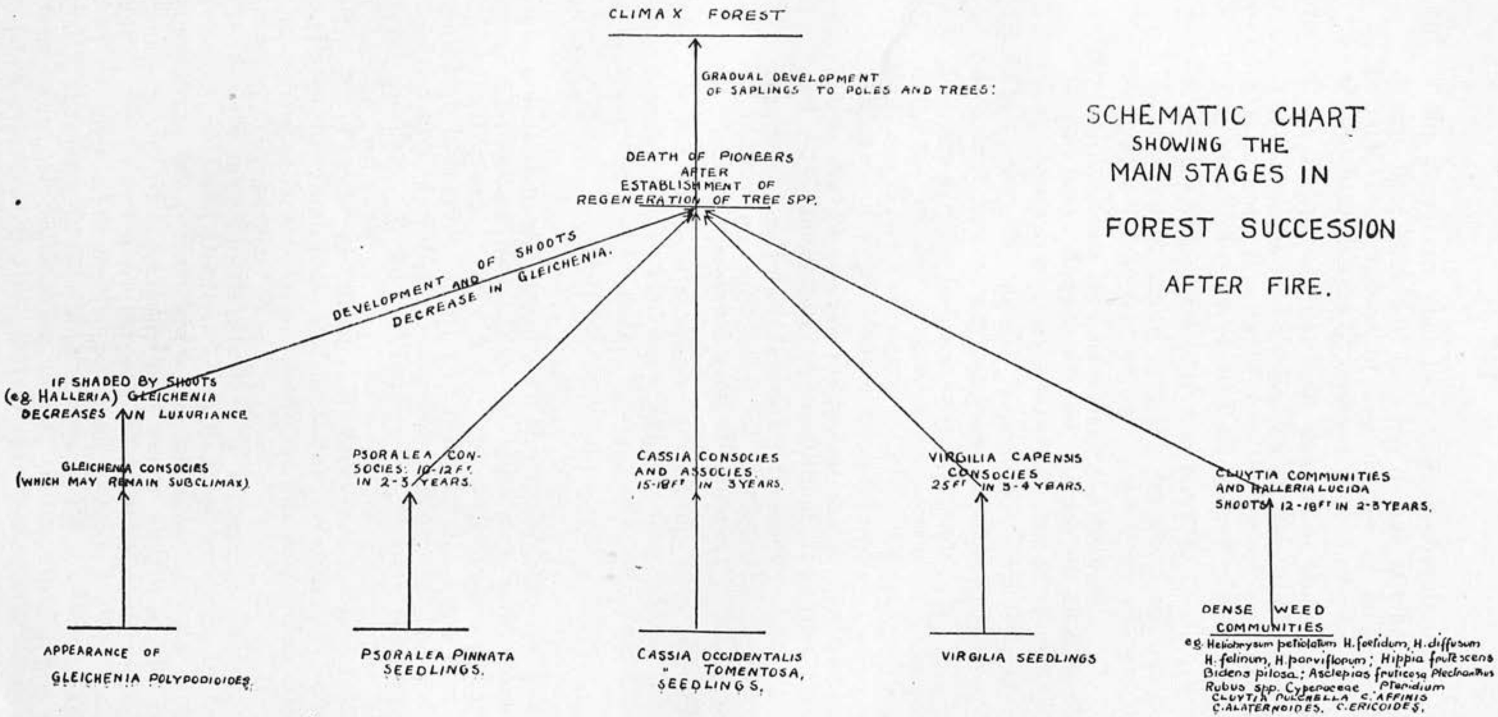
Summing up the data therein given, it is seen that—

8 species (12.6%) show a *very low* degree of efficiency (1%-5%);
39 species (61.9%) show a *low* degree of efficiency (6%-20%);
13 species (20.6%) show a *medium* degree of efficiency 21%-40%);
3 species (4.9%) show a *high* degree of efficiency (41%-80%).

It is interesting to observe the following:—

(*a*) Of the 24 species that bear flowers *very abundantly*,
1 sp. bears flowers of *very low* degree of efficiency;
11 spp. bear flowers of *low* degree of efficiency;
9 spp. bear flowers of *medium* degree of efficiency;
3 spp. bear flowers of *high* degree of efficiency.

XXVII.


CLIMAX FOREST
GRADUAL DEVELOPMENT OF SAPLINGS TO POLES AND TREES:
SCHEMATIC CHART SHOWING THE MAIN STAGES IN FOREST SUCCESSION AFTER FIRE.
DEATH OF PIONEERS AFTER ESTABLISHMENT OF REGENERATION OF TREE SPP.
DEVELOPMENT OF SHOOTS AND DECREASE IN GLEICHENIA.
IF SHADED BY SHOOTS (e.g. HALLERIA) GLEICHENIA DECREASES IN LUXURIANCE
GLEICHENIA CONSOCIES (WHICH MAY REMAIN SUBCLIMAX)
APPEARANCE OF GLEICHENIA POLYPODIOIDES.
PSORALEA CONSOCIES: 10-12 FT. IN 2-3 YEARS.
PSORALEA PINNATA SEEDLINGS.
CASSIA CONSOCIES AND ASSOCIES. 15-18 FT IN 3 YEARS.
CASSIA OCCIDENTALIS
" TOMENTOSA, SEEDLINGS.
VIRGILIA CAPENSIS CONSOCIES 25 FT IN 3-4 YEARS.
VIRGILIA SEEDLINGS
CLUYTIA COMMUNITIES AND HALLERIA LUCIDA SHOOTS 12-18 FT IN 2-3 YEARS.
DENSE WEED COMMUNITIES
e.g. Helichrysum petiolatum H. foetidum, H. diffusum
H. felinum, H. parviflorum; Hippia frutescens
Bidens pilosa.; Asclepias fruticosa Plectranthus
Rubus spp. Cyperaceae. Pteridium
CLUYTIA PULCHELLA C. AFFINIS
C. ALATERNOIDES. C. ERICOIDES.

(*b*) Of the 20 species that bear flowers *abundantly*,
3 spp. bear flowers of *very low* degree of efficiency;
15 spp. bear flowers of *low* degree of efficiency;
2 spp. bear flowers of *medium* degree of efficiency.

(*c*) Of the 12 species that bear flowers *in moderate numbers*,
3 spp. bear flowers of *very low* degree of efficiency;
8 spp. bear flowers of *low* degree of efficiency;
1 sp. bears flowers of *medium* degree of efficiency.

(*d*) Of the 5 species that bear *few* flowers,
1 sp. bears flowers of *very low* degree of efficiency;
4 spp. bear flowers of *low* degree of efficiency.

(*e*) Of the 2 species that bear *very few* flowers,
1 sp. bears flowers of *low* degree of efficiency;
1 sp. bears flowers of *medium* degree of efficiency.

(*f*) When the 44 species producing *very abundant* and *abundant* flowers are combined, it is seen that
10% are of *very low* degree of efficiency;
60% are of *low* degree of efficiency;
23% are of *medium* degree of efficiency;
7% are of *high* degree of efficiency.

(*g*) When the 19 species producing *moderate numbers*, *few*, and *very few* flowers, are combined, it is seen that
21% are of *very low* degree of efficiency;
68.5% are of *low* degree of efficiency;
10.5% are of *medium* degree of efficiency.

Thus, on the whole, the species producing *very abundant* and *abundant* flowers, are rather more efficient than those producing flowers in *moderate numbers*, *few* flowers, and *very few* flowers.

3. *Pollination.*

Cross pollination is carried out chiefly by *Apis mellifica* and *A. caffra; Anthophora* and *Xylocopa spp.* play some part, while Lepidoptera, Diptera, and Ants are relatively unimportant. Nectariniidae (*Cinnyris afer*, *C. chalybeus*), *Promerops cafer*, *Zosterops capensis*, and *Estilda astrilda*, account for the pollination of several species. Wind pollination is relatively unimportant, except in the instances of the anemophilous *Podocarpus elongata* L'Herit., *P. Thunbergii* Hook., *Widdringtonia cupressoides*, and the partially anemophilous *Trichocladus crinitus*, *T. ellipticus*, *Trimeria alnifolia*, *Brachylaena neriifolia*, *Tarchonanthus camphoratus*, *Lachnostylis capensis*.

The flowers may be classified with respect to Colour, Odour, Pollination Agents and Degree of Fertilization, as shown in *Table II*.

Competition for pollination is not particularly keen among the indigenous species of trees and large woody shrubs at the Knysna.

This is due to two main causes: (*a*) It is only very occasionally that two or more abundantly flowering species are in blossom at identically the same time; (*b*) the Honey Bee, which is the most important agent of pollination, selects pollen from some species, nectar from others, and thus distributes its favours fairly evenly.

A point of considerable interest and of some importance biologically, is the increasing attraction that exotic trees—Eucalyptus spp.

particularly—have for the Honey Bee. Exotics near the Forests and several miles removed therefrom, are constantly visited by swarms that have their headquarters in the indigenous Forests.

Often swarms endeavour to make their headquarters in exotic plantations, and will put up with much hardship so far as sites for their hives are concerned if the Eucalypt flowers are profuse and in tempting condition. The role of the Honey Bee in bringing about hybridization of the Eucalypts will probably repay investigation.

4. *Nature of the Fruits, and Seeds.*

The nature of the fruits and seeds of the more important Forest trees and large shrubs is summarized in *Table III.*

5. *Dispersal of Fruits and Seeds.*

Table 3 shows that the larger number of the fruits are either drupaceous or baccate. Judging from this, one would conclude that the major role in seed dispersal is played by birds and mammals.

Observation supported by the examination of faeces, of shot birds and mammals, and experimental sowings of known numbers of fruits or seeds upon quadrats placed under close observation, proves this supposition to be correct.

As information concerning the parts played by the various Forest birds and mammals in fruit and seed dispersal is exceedingly meagre—apart from passing reference by Marloth (1894) and in several of Bews's ecological papers there is no literature—the following summary of results obtained after some $3\frac{1}{2}$ years careful work on this important subject is of interest:—

Following Clements (1905; 1907; 1916), the subject of *dispersal* is divided into *simple aggregation* and *migration*. *Simple aggregation* may be defined as the grouping of fruits and seeds about the plant producing them; *migration* is the process whereby a fruit or seed is borne to an area beyond that directly influenced by the parent plant. In dealing with trees the writer (1924: 286; 1925: 156), has used the term "*crown-influence-zone*" to express the area immediately sheltered or otherwise influenced by the crown; movements of germules within this zone are considered as *simple aggregation*, and those beyond as *migration*. The line of division between *simple aggregation* and *migration* is not a clear-cut one, for obviously movement within the *crown-influence zone*, no matter how insignificant is in a sense *migration*. Reasons for drawing what may appear to be an unnecessarily fine distinction between the processes are:—(*a*) movement within the *crown-influence-zone* bears a different relation to germination, establishment and growth, from movement beyond that zone; (*b*) *simple aggregation* increases the individuals of a species, thus tending to produce dominance, while *migration* has the opposite effect—general mixing of species.

(*a*) *Simple Aggregation.*—Of the millions of fruits borne by the Forest trees of the Knysna seldom more than *from less than* 1 *per cent. to* 10 *per cent.* (varying with species and locality) ever move beyond the *crown-influence-zones* of the parents.

This is demonstrated by capsule, drupe, berry, and cone bearing species alike, the proportion of migration being higher in the species that produce drupes or berries of edible nature.

Platylophus trifoliatus, *Cunonia capensis*, *Nuxia floribunda*, *Chilianthus arboreus*, are examples of capsule-bearing species. The writer (1925: 156), has shown that as many as 10,048 capsules of Platylophus may fall upon 1 square metre of the *crown-influence-zone* in the course of a single fruiting season. *Cunonia capensis*, the capsules of which contain about 40 minute seeds each, often sheds *several hundred thousand* germules per square metre. Despite the possession of membranous wings the seeds are very seldom wind borne; they are destroyed by water; birds and mammals do not carry them except by accident; they therefore accumulate under the parent tree by the million. *Nuxia floribunda* and *Chilianthus arboreus* repeat the tale of the two species just mentioned.

Edible drupes and berries are borne by *Ocotea bullata*, *Olea laurifolia*, *O. capensis*, *O. foveolata*, *Elaeodendron capense*, *E. croceum*, *Ekebergia capensis*, *Ilex capensis*, *Halleria lucida*,- *Olinia cymosa*, *Curtisia faginea Myrsine melanophleos*, *Sideroxylon inerme*, *Plectronia obovata*, *P. Mundtii*, *P. ventosa*, *Dovyalis rhamnoides*, *Rhamnus prinoides*, *Scutia Commersonii* and other species, and fruits with succulent and edible arils by *Podocarpus spp.*, yet the percentage of the crops borne that migrates is small in every instance. The largest percentage of migration are exhibited by *Olea laurifolia*, *O. capensis*, *O. foveolata*, *Podocarpus spp.*, *Halleria lucida*, *Elaeodendron capense*, *E. croceum*, intermediate values by *Ekebergia capensis*, *Olinia cymosa*, *Myrsine melanophleos*, and *Ocotea bullata*, and the smallest, almost negligible values by *Ilex capensis*, *Curtisia faginea*, Plectronia spp., *Dovyalis rhamnoides*, *Sideroxylon inerme*, *Rhamnus prinoides and Scutia Commersonii.*

Non-palatable fruits such as those of *Apodytes dimidiata*, *Cassinopsis capensis*, and *Fagara Davyi*, and poisonous ones such as those of *Acokanthera venenata*, are still more confined to the area influenced by the crown of the parent.

Aggregation does not by any means result in producing dense stands of seedlings on the *crown-influence-zone* in every instance. The species of tree, the community and habitat conditions, and the very concentration of fruits itself, often inhibit successful germination and establishment; Fungi and Insects of parasitic and predaceous nature often become rampant owing to the accumulation of fruits, while in dense stands of young seedlings competition for moisture and solutes as well as for very space itself is so intense that death of large proportions of the seedling-communities takes place.

(*b*) *Migration*.—Migration in all species (except *Virgilia capensis*, *Podocarpus elongata*, *Olea laurifolia*, *Olea capensis*, *Olea foveolata*, *Elaeodendron capense* and *E. croceum* in occasional instances) is over very short distances—seldom exceeding distances from a few yards to several miles. The fruits or seeds of the species above mentioned, however, may be borne by streams and rivers (e.g. *Virgilia*, *P. elongata*, *Olea spp.*) for considerable distances, or by far-flying birds (all spp. listed except *Virgilia*).

Examination of Macchia at various distances—from several hundred yards to several miles—has shown the presence of scattered seeds of the species listed except Virgilia, in bird and mammal faeces. Young seedlings are to be found in localities that have not been burnt for several years and that have provided suitable conditions for germination and establishment.

Owing to demands of space it is not possible to list the various species of fruit according to each of the many bird and mammal agents responsible for their dispersal, but a general classification of the species of fruits under the main headings "Birds and mammals" is furnished, together with notes concerning the principal migration agents. Wind and water borne fruits are dealt with as well. (Vide *Table IV.*)

The relation of fruit and seed dispersal to general distribution of species is a complicated subject, but at all events two important generalizations can be made respecting it. (1) Migration has been an exceedingly slow process in the instance of most of the South African Forest trees, owing not only to difficult conditions of both habitat and community, but also to the relatively inefficient means of dispersal. (2) During the course of the ages birds and mammals have played a most important part in the distribution of plants; it is a striking feature in Macchia and Scrub that the Forest species advance along and from moist kloofs and stream and river beds—birds and mammals frequent such localities and supply them with the germules of Forest spp.

6. *Germination and Establishment.*

The related subjects of viability of seeds, germination, and establishment of seedlings of the more important tree species have been submitted to quantitative, experimental study since January, 1923. A summary of available information relating to viability of seeds, chief agents of mortality, and average period required for germination under normal Forest conditions is provided in *Table V.* The subject of establishment of young regeneration has been studied by quadrat methods. In *Table VI* is summarized information at present available concerning the degree of successful establishment and the principal biotic causes of poor growth or death, for the principal Forest species.

Concerning regeneration there are in addition several points of general importance requiring record:—

Regeneration for one and the same species varies considerably in quantity and quality according to locality. Thus—*Hemitelia capensis*—clad areas (on which also occur *Blechnum capense*, *Marattia fraxinea*, and various smaller ferns) of low Light-intensity (1/500 to 1/1,000 at seedling level on bright, clear days from 11 a.m. to 3 p.m., when the Light-intensity under full exposure to the sun is 1—per Clements's Stopwatch Photometer), high Relative Humidity (an average of from 85 to 95 per cent.), high Holard (from 120 to 220 per cent. on dry-weight of ovened samples), and high soil-acidity (pH 4.0 to pH 4.4 at 6 inches below the surface) support little or no regeneration. Germules falling upon such areas meet with many factors inimical to their germination so that the mortality percentage is high; such as do germinate produce weakly plants that are either killed by parasitic Fungi and Insects and by physiological diseases, or establish themselves with difficulty and grow exceedingly slowly. There are, too, the extensive *Trichocladus crinitus* layers typical of medium-moist and dry Forests; these dense layers cut down the Light-intensity considerably (from 1/500 to 1/350 on bright clear days from 11 a.m. to 3 p.m., when the Light-intensity is 1—per Clements's Stopwatch Photometer). The *Trichocladus* removes much of the moisture from the upper 6 to 9 inches of the soil, the small and relatively delicate seedlings of Forest tree species being unable to compete with it successfully. While there usually are many more seedlings under *Trichocladus* than there are under the *Hemitelia* layers, the stocking of young plants is nevertheless very poor.

Areas from which *Hemitelia* and *Trichocladus* and the dense communities of *Aspidium capense* Willd (*Polystichum adianteforme* J. Sm.) are absent, or areas on which they are sparse, usually show very fair regeneration of most species. Dense layers of the tall, luxuriant *Plectranthus fruticosus,* and of *Carex aethiopica,* are frequently found in moist Forest; these cut down the Light-intensity as much as does the *Hemitelia,* while the Holard of the areas covered by them is often high (from 80 to 120 per cent. on dry-weight of ovened samples) and the pH values low; (from pH 4.3 to pH 4.8)—such communities do not allow of the establishment of regeneration of tree species beneath their cover.

Considering the complex nature of the primeval Forests and the various peculiarities of the constituent species and putting aside the poverty of regeneration under dense communities of ferns and shrubs and tall herbs, the natural regeneration must be looked upon as excellent. There is certainly more regeneration in an average portion of Knysna primeval Forest than there is in equivalent portions of many of the best mixed Forests of the British Isles and of Europe.

Assistance from the Forester in the directions of introduction of more light to a regulated degree, and decrease of competition with various useless shrubs and weeds, results in the production of more and of better-class regeneration. Excessive removal of high cover, however, usually results in either death or stunting of the existing regeneration, while fresh plants are prevented from developing on account of the dense light-demanding and light-bearing weeds (e.g. *Helichrysum petiolatum, H. parviflorum, H. diffusum, Rubus fruticosus, R. pinnatus, Hydrocotyle spp., Plectranthus fruticosus,* and *Carex aethiopica*) that immediately appear.

Such plants as appear simultaneous with the first weeds are very often lesioned at the collars by the excessive temperature of the soil surface. (140 to 165 deg. Fahr. from noon to 3 p.m. on hot summer or winter days.)

After the dense weed communities have been killed out or weakened by the shade cast by coppice of *Halleria lucida*, and by fast growing shrubs such as *Cluytia pulchella, C. affinis, Rhamnus prinoides, Osteospermum moniliferum,* and *Polygala myrtifolia,* regeneration of the best tree species is able to establish itself and to develop more rapidly than under the dense cover of unexploited primeval Forest. Thorough defeat of the weeds, however, may be delayed for periods ranging from 5 to over 20 years.

The mortality figures for the regeneration of certain species are very high, but this is to be expected as the output of seedlings is in these species extravagantly superabundant; death of large numbers of the plants is an essential to the successful development of a few. The mortality factor is fully discussed in a paper to appear later.

A point of the very greatest interest, but one not at all easy to explain. is the truly excellent manner in which the Yellow-wood, *Podocarpus Thunbergii Hook* (*P. latifolius R.Br.*) regenerates.

Podocarpus is a relatively primitive conifer, although it does not appear to have been recorded from beds earlier than the Miocene (*vide* Knowlton's list in "Plant Succession," F. E. Clements, 1916).

It might be suggested that the Knysna Forests were in past ages pure *Podocarpus* communities, and that these Gymnosperms are being slowly ousted by Angiospermous trees; this supposition, however, is certainly not supported by the present efficient manner in which *P. Thunbergii* (and in places, *P. elongata L'Herit* as well) regenerates. Perhaps the regeneration process, though still so excellent, has with the centuries gradually decreased in efficiency, and possibly the incoming hordes of Flowering trees and shrubs are slowly but surely gaining the upper hand.

Summary.

1. The behaviour of some 63 species of trees and shrubs occurring in the Knysna forests with respect to seasons of flowering and fruiting is described in tabular form. (*Table I.*)*
The influence of proximity to the sea is discussed.

2. The quantity of the flowers produced by certain species and the efficiency of these flowers are described in general.

3. Principal agents of pollination are listed for each of the 63 species, and the degree of efficient pollination (that is of fertilization) is described for each. Colour and size, and odour of the blossoms are briefly described. *Table II.*)

4. The nature of the fruits and seeds of the 63 species is summarized under the headings "Cones and Capsules," "Berries and Drupes," "Miscellaneous." (*Table IIIA/IIIB/IIIC.*)

5. Dispersal of the fruits and seeds of the 63 species is summarized under heading of the principal agents of dispersal: Wind, Water, Birds, Mammals, Man, and Various. (*Table IV.*) Dispersal is generally discussed, and the desirability of employing the *Aggregation* and the *Migration* concepts is touched upon.

6. Information relating to viability, chief agents of mortality, and average period required for germination of seeds, is summarized in *Table V.*

7. Degree of establishment and principal biotic agencies of disease and destruction are described in *Table VI.* Apart from areas overstocked with *Hemitelia capensis* and other ferns, and with *Trichocladus crinitus*, the forests are well stocked with regeneration and compare favourably with mixed hardwood forests in Europe and the British Isles.

8. The summarized information given in the six tables is the result of phenological studies of definitely marked trees over a period of about $3\frac{1}{2}$ years, study of the structure of fruits and flowers, pollination experiments under natural and under controlled conditions, observations and experiments connected with the dispersal of fruits and seeds, and nursery and quadrat germination experiments.

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* Tables of Appendix I.

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Table I.

FLOWERING AND FRUITING SEASONS; MORE IMPORTANT KNYSNA FOREST TREES AND SHRUBS.

Species.	Flowering Seasons (Full).	Usual Time of the Year.	Fruits are Mature.	Fruits are Fallen.	Periods Separating *Full* Fruiting Seasons.
Podocarpus elongata L'Herit	Every 2nd or 4th year	August–October........	9–12 months after fertilization	10–15 months after fertilization	Every 2nd or 4th year.
Podocarpus Thunbergii Hook	Every 2nd year, but a *few* flowers every year	August–October........	6–9 months after fertilization	7 to 12 months after fertilization	Every 2nd year.
Widdringtonia cupressoides, endl.	Every year............	September–October.....	12 months after fertilization	Seeds escape 18–24 months after fertilization	Every 2nd year.
Olea laurifolia, Lamk....	Variable, may take place 2nd, 3rd, or 4th year	January–May..........	12–18 months after fertilization	A large proportion fall prematurely; viable fruits fall 15–18 months after fertilization	Full flower crops usually produce full fruit crops, hence latter may occur every 2nd, or 3rd or 4th year.
Olea capensis L.........	Every year............	August–January........	6–8 months after fertilization	As soon as mature many fall prematurely	Full crops annually.
Oleo foveolata E. Mey..	Every 3rd year........	September–December...	6–7 months after fertilization	As soon as mature; many fall prematurely	Full crops once in 3 years.
Ocotea bullata, E. Mey..	Variable—some trees every month in every year, some at intervals of 6, 12 24 months	Any month............	1½–2 months after fertilization; rarely reach mature size or colour on tree	Usually fall prematurely	Very variable—from several months to several years according to tree and site.
Apodytes dimidiata, E. Mey.	Variable—every 2nd or 3rd or 4th year according to tree and site	November–February....	6–8 months after fertilization	Mostly fall prematurely; mature fruits fall 6–9 months after fertilization	Some flower-crops produce no fruits; full crops usually every 3rd year.
Cassinopsis capensis Sond.	Every year............	October–March.........	3–4 months after fertilization	Fall as soon as mature	Full crops annually.
Curtisia faginea, Ait.....	Usually every year.....	Variable, but often October–March	6–10 months after fertilization	7–12 months after fertilization	Poor fruit-crops at times follow good flower-crops; this is due to a fungus which galls the flowers; most trees, however, produce fair crops every year.
Platylophus trifoliatus, Don.	Every year............	December–February.....	6–8 weeks after fertilization	8–10 weeks after fertilization	Heavy crops annually.

Table I.—(Continued).

FLOWERING AND FRUITING SEASONS; MORE IMPORTANT KNYSNA FOREST TREES AND SHRUBS.

Species.	Flowering Seasons (Full).	Usual Time of the Year.	Fruits are Mature.	Fruits are Fallen.	Periods Separating *Full* Fruiting Seasons.
Cunonia capensis L.....	Every year; some trees every 2nd year	February–May, or June–August	4–7 weeks after fertilization	6–9 weeks after fertilization—the entire fruiting spike falling	Heavy crops annually, unless flowers of the season happen to be diseased.
Nuxia floribunda Benth.	Every 2nd year........	May–August...........	4–6 weeks after fertilization	Fruits persist for 3–4 months	Heavy crops usually follow the flower-crops unless the latter are fungus-infected.
Chilianthus arboreus A.DC.	Every year...........	August–January........	$1\frac{1}{2}$–2 months after fertilization	Seeds escape as soon as mature	Full crops annually.
Olinia cymosa, Thunb...	Variable; may occur every 2nd, 3rd or 4th year	June–November........	10–14 months after fertilization	12–24 months; some are long persistent on the branches	Every 3rd or 4th year; some flower-crops are followed by very poor fruit-crops or by no fruits at all.
Ilex (capensis) mitis, Radlk.	Every year...........	October–February......	2–3 months after fertilization	Fall as soon as mature	A few fruits each year, but full crops every 3rd year.
Kiggelaria africana L....	Every 2nd or 3rd year, but a few flowers every year	November–January.....	2–3 months after fertilization	Fall as soon as mature.	Heavy crops at 3-year intervals, but a few fruits occur every year.
Scolopia Mundtii Arn....	Every 2nd year........	December–May.........	3–4 months after fertilization	Fall as soon as mature.	Fruits appear in alternate years—always few.
Scolopia Zeyheri, Syzl...	Every 2nd year........	December–May.........	3–4 months after fertilization	Several days after maturity	Fruits appear in alternate years—seldom abundant.
Trimeria alnifolia Planch.	Every year...........	November–April; females slightly earlier than males	1–$1\frac{1}{2}$ months after fertilization	Capsules persist 2–4 weeks after maturity	Full crops annually.
Dovyalis rhamnoides Burch.	Every year...........	September – February; females slightly earlier than males	3–4 months after fertilization	As soon as mature; many fall prematurely	Fruits very rarely—reputed full crops at 7–9 year intervals; intervals certainly not less than 4 years.
Myrsine melanophleos R. Brr.	Every 2nd year........	July–August..........	2–3 months after fertilization	3–4 months after fertilization; some persist for many months	Heavy crops every 2nd year.

Table I.—(Continued.)

FLOWERING AND FRUITING SEASONS; MORE IMPORTANT KNYSNA FOREST TREES AND SHRUBS.

Species.	Flowering Seasons (Full).	Usual Time of the Year.	Fruits are Mature.	Fruits are Fallen.	Periods Separating *Full* Fruiting Seasons.
Faurea MacNaughtonii, Phill.	Annually; rarely at 2-year intervals	March–May............	6–8 weeks after fertilization	9–12 weeks after fertilization; some long persistent	Good crops usually annual, unless weather at time of flowering be very wet.
Virgilia capensis Lamk..	At 6–12 month-intervals, but very variable	Any month, but chiefly July–September	3–4 months after fertilization	5–6 months after fertilization; some persist for over 12 months	Very variable; some flower-crops produce no fruits, others large numbers; usually a good crop once per year.
Gonioma Kamassi, E. Mey.	3 or more years separate the seasons; a few flowers may be borne every year by some individuals	Usually October–April, but rather variable	6–8 weeks after fertilization	The light, winged seeds escape immediately the follicles open; follicles open 1–3 weeks after they are fully mature	Heavy flower crops in some instances produce very full fruit-crops, but in others, very poor ones.
Carissa arduina Lamk..	Every year............	October–March.........	1½–2 months after fertilization	As soon as mature; many fall prematurely	In forests fruits rarely; intervals between fair crops not less than 4 years.
Acokanthera venenata G. Don.	Every year............	August–March..........	2–3 months after fertilization	1–2 weeks after maturity	Full crops annually.
Calodendron capense Thunb.	Annually; some trees in alternate years only	November–January, some trees as late as early March	6 months after fertilization	About 7 months after fertilization the woody capsules dehisce	Poor fruit crops the rule.
Toddalia lanceolata Lam.	Every year............	November–March.......	2–3 weeks after fertilization	2–3 weeks after maturity	At 2 year intervals.
Fagara Davyi Verdoorn..	At 3 year intervals.....	November–May.........	1–1½ months after fertilization	2–4 weeks after maturity; some persistent several months	At 3 year intervals.
Pterocelastrus variabilis, Sond.	Annually in many instances; other trees in alternate years only	September–February....	2–3 months after fertilization	Seeds escape several weeks after capsules are mature	Alternate years see the production of good crops.
Elaeodendron croceum (Thunb.) D.C. and E. capense E. and Z.	Annually in most instances; some trees at intervals of 2–3 years	November–February....	10–12 months after fertilization	1–1½ months after maturе; some are persistent for 3–4 months	Rarely 1 year, usually 2 years between fruit crops.

Table I.—(Continued.)

FLOWERING AND FRUITING SEASONS; MORE IMPORTANT KNYSNA FOREST TREES AND SHRUBS.

Species.	Flowering Seasons (Full).	Usual Time of the Year.	Fruits are Mature.	Fruits are Fallen.	Periods Separating *Full* Fruiting Seasons.
Elaeodendron Kraussianum, Sim.	Every year...........	January–May..........	3–4 months after fertilization	as soon as mature......	Every year some fruits; full crops 2–3 year intervals.
Celastrus acuminatus L..	Every year...........	December–March.......	2 months after fertilization	As soon as mature.....	Full crops annually.
Celastrus peduncularis, Sond.	Every year...........	November–March.......	2 months after fertilization	As soon as mature.....	Full crops annually.
Celastrus buxifolius, L..	Every year...........	September–January.....	2–2½ months after fertilization	2–4 weeks after maturity	Full crops annually.
Halleria lucida L.......	Annually.............	July–September........	3 months after fertilization	The larger proportion before they are mature; those that do reach maturity fall immediately they are ripe	Annually.
Plectronia spp. (P. obovata, Sim., P. Mundtii, P. ventosa) L. Pappe	Usually annually: some trees miss alternate years	November–February....	3–4 months after fertilization	As soon as mature.....	Many trees bear full crops annually, others miss alternate years.
Burchellia capensis DC..	Annually; some trees miss alternate years.	October–February	3–4 months after fertilization	6-8 months after fertilization; some are very long persistent	Most trees bear annually; some miss alternate years.
Gardenia Rothmannia L.	Annually.............	October–March..........	3–4 months after fertilization	1–2 months after maturity is reached	Annually.
Royena lucida, L.......	Annaully.............	August–November......	3–4 months after fertilization	As soon as mature; a large proportion fall before maturity is reached	Annually.
Euclea spp. (E. macrophylla, E. Mey., E. racemosa, Murr., E. lanceolata), E. Mey.	Annually.............	December–March.......	2 months after fertilization	As soon as mature......	Very irregular: some at 2 year intervals, others at 3– more year intervals.
Sideroxylon inerme L....	Every year...........	September–March.......	3–4 months after fertilization	Persist 2–3 weeks after they reach maturity	Full crops annually.
Rhus laevigata L.......	Every year...........	October–February......	2 months after fertilization	Fall soon after maturity	Full crops annually.
Brachylaena neriifolia R.Br.	Every year...........	December–February; females earlier than males	2–3 weeks after fertilization	As soon as mature; many fall prematurely	Full crops annually.

Table I.—(Continued.)

FLOWERING AND FRUITING SEASONS; MORE IMPORTANT KNYSNA FOREST TREES AND SHRUBS.

Species.	Flowering Seasons (Full).	Usual Time of the Year.	Fruits are Mature.	Fruits are Fallen.	Periods Separating *Full* Fruiting Seasons.
Tarchonanthus camphoratus L.	Every year...........	December–April; females earlier than males	3–4 weeks after fertilization	Persist for several weeks after mature	Full crops annually.
Sparmannia africana L.f.	Every year...........	October–June..........	4–6 weeks after fertilization	Seeds escape as soon as mature	Full crops annually.
Trichocladus crinitus Pers.	Every year...........	December–May.........	1½–2 months after fertilization	Seeds escape soon as mature	Full crops annually.
Trichocladus ellipticus E. and Z. (rare and local)	Every year...........	January–May..........	1½–2 months after fertilization	Seeds escape soon as mature	Full crops annually.
Ochna arborea Burch....	Every 2nd year........	December–April........	2–2½ months after fertilization	As soon as mature.....	Full crops every 2nd year.
Ochna arborea Burch....	Every 2nd year........	December–April........	2–2½ months after fertili-	As soon as mature.....	Full crops every 2nd year.
Ochna atropurpurea D.C.	Every 2nd year........	December–April........	2–2½ months after fertilization	As soon as mature.....	Full crops every 2nd year.
Lachnostylis capensis Turcz	Every year...........	October–January.......	2–3 months after fertilization	As soon as mature.....	Every 2nd year.
Ekebergia capensis Sparm.	Every year...........	October–March.........	4–5 months after fertilization	Persist 3–4 weeks after maturity	Every 3rd year.
Ficus capensis Thunb....	Every year...........	October–January.......	2–2½ months after fertilization	Persist 3–4 weeks after maturity	Full crops every 2nd year.
Celtis rhamnifolia Presl.	Every 2nd year........	October–February......	1½–2 months after fertilization	Fall soon as mature.....	Full crops once in 4 years.
Pittosporum viridiflorum Sims.	Every 3rd year, but very variable	November–February....	3–4 months after fertilization	Several days after maturity	Very rarely produces full crops—at least 3–4 years between medium crops.
Rhamnus prinoides L'Herit	Every year...........	October–March.........	2–2½ months after fertilization	As soon as mature.....	Full crops annually.
Scutia (indica) Commersonii Brogn.	Every year...........	October–February.......	2–2½ months after fertilization	As soon as mature.....	Full crops rare in forests—2–3 years apart; outside forests full crops annually.

Table II.

FLOWERS: KNYSNA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and Size.	Odour.	Agents of Pollination.							Degree of Efficient Pollination.†
			Self.	Wind.	Apis mellifica and A. caffra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Nectariniidae and Promerops Caffer.*	Various.	
Podocarpus elongata, L'Herit	*Male*, Cream *Female*, Green	Nil	—	‡	—	—	—	—	—	Low.
Podocarpus Thunbergii, Hook	*Male*, Cream *Female*, Green	Nil	—	‡	—	—	—	—	—	Low.
Widdringtonia cupressoides	Green	Nil	—	‡	—	—	—	—	—	Low.
Olea laurifolia..........	White or cream; minute	Sweet, sickly; medium	‡	—	‡Seeking pollen	—	—	—	—	Medium.
Olea capensis..........	White or cream; minute	Sweet, sickly; medium	‡	—	‡Seeking pollen	—	—	—	—	Medium.
Ocotea bullata..........	White or cream; minute	Laurel; faint	‡	—	—	—	—	—	—	Low (*vide* J. F. Phillips, 1924).
Olea foveolata..........	White or cream; minute	Laurel; faint	‡	—	‡Seeking pollen	—	—	—	—	Low.
Apodytes dimidiata......	White or cream; minute	Sweet, rich, heavy; strong	‡	—	‡Seeking pollen	—	—	—	—	Low.
Cassinopsis capensis......	Cream; minute	Sweet, faint	‡	—	‡Seeking pollen	—	—	—	—	Medium.
Curtisia faginea..........	Fawn to dirty cream; minute	Nil	‡	—	—	—	—	—	—	Medium.

*† Details on page 267.

Table II.—(Continued).

FLOWERS: KNYSNA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and Size.	Odour.	Agents of Pollination.							Degree of Efficient Pollination.†
			Self.	Wind.	Apis mellifica and A. caffra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Nectariniidae and Promerops Caffer.*	Various.	
Platylophus trifoliatus...	White or cream; minute	Sweet, rich heavy; strong	‡	—	‡Seeking nectar	‡	‡	‡	—	High (50 to 80 %.)
Cunonia capensis........	White or cream; minute	Sweet; rich heavy; strong	‡	—	*Seeking nectar	‡	‡	‡	—	High.
Nuxia floribunda........	White or cream; minute	Sweet, rich; medium	‡	—	‡Seeking nectar and pollen	‡	—	—	Ants, Melolonthinae, Diptera	Low.
Chilianthus arboreus.....	Cream; minute	Sweet, rich	‡	—	‡Seeking pollen	—	—	—	Ants Diptera	Low.
Olinia cymosa...........	Cream; minute (sometimes few pink markings)	Rich almond; strong	‡	—	‡Seeking nectar, but more often pollen	‡	—	‡Especially if infected by Aphids	Aphid larvae	Low.
Ilex mitis..............	Cream; minute. sometimes few pink markings)	Sweet; faint	‡	—	‡Seeking pollen	—	—	—	—	Low.
Kiggelaria africana......	(Dioecious) females larger than males, but minute, cream	Sweet; faint	—	—	‡Seeking nectar from females, pollen from males	—	—	—	—	Low.
Scolopia Mundtii........	Cream; minute	Sweet; faint	‡	—	‡Seeking pollen	—	—	—	—	Low.
Scolopia Zeyheri........	Cream; minute	Sweet; faint	‡	—	‡Seeking pollen	—	—	—	—	Low.

Table II.—(Continued).

FLOWERS: KNYSNA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and Size.	Odour.	Agents of Pollination.							Degree of Efficient Pollination.†
			Self.	Wind.	Apis mellifica and A. caffra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Nectariniidae and Promerops Caffer.*	Various.	
Trimeria alnifolia........	(dioecious) males and females, greenish, very small	Nil	—	‡	—	—	—	—	—	Low.
Dovyalis rhamnoides.....	(dioecious) females larger than males, but minute; cream	Females; sweet	—	—	‡Seeking nectar from females, pollen from males	—	—	—	Ants	Very low.
Myrsine melanophleos....	Cream; minute	Nil, or very faint	‡	—	‡Seeking pollen	—	—	—	Ants	Medium.
Faurea MacNaughtonii..	Faint pink to white; medium	Sweet	‡	—	‡Seeking pollen, sometimes nectar	‡	‡	‡	Ants Melolonthinae	High.
Virgilia capensis.........	Pink, showy; medium	Very faint or nil	—	—	—	‡	‡	‡	Melolonthinae	Medium.
Gonioma Kamassi.......	Cream or very pale yellow; medium	Sweet; rich strong	‡	—	—	‡	‡	‡	—	Very low.
Carissa arduina.........	Waxy-white; medium	Sweet; rich	‡	—	‡Seeking nectar	‡	‡	—	Ants	Low in Forests high under full light.
Acokanthera venenata...	Waxy-white, pink-tinted; medium	Sweet, rich, sickly	‡	—	‡Seeking nectar	‡	‡	—	Ants Diptera	Low.

Table II.—(Continued).

FLOWERS: KNYSNA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and Size.	Odour.	Agents of Pollination.							Degree of Efficient Pollination.†
			Self.	Wind.	Apis mellifica and A. caffra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Nectariniidae and Promerops Caffer.*	Various.	
Calodendron capense.....	Mauve; showy; medium	Very faint or nil	‡	—	‡Seeking pollen	‡	‡	‡	Ants	Very low.
Toddalia lanceolata......	(Dioecious) greenish, minute	Nil	—	—	‡Seeking pollen from males and nectar from females	—	—	—	—	Low.
Fagara Davyi...........	(Dioecious) greenish-yellow; minute	Nil	—	—	‡Seeking pollen from males and nectar from females	—	—	—	Ants	Very low
Pterocelastrus variabilis..	White; minute	Sweet; medium	‡	—	‡Seeking pollen (often nectar as well)	—	—	—	—	Low.
Elaeodendron croceum...	White; minute	Faintly sweet	‡	—	‡Seeking pollen and nectar	—	—	—	—	Low.
Elaeodendron capense....	White; minute	Faintly sweet	‡	—	‡Seeking pollen and nectar	—	—	—	—	Low.
ElaeodendronKraussianum	White; minute	Faintly sweet	‡	—	‡Seeking pollen and nectar	—	—	—	—	Very low.
Celastrus acuminatus.....	Straw or cream; minute	Sweet, rich	‡	—	‡Seeking pollen and nectar	—	—	—	—	Low.

Table II.—(Continued).

FLOWERS: KNYSNA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and Size.	Odour.	Agents of Pollination.							Degree of Efficient Pollination.†
			Self.	Wind.	Apis mellifica and A. caffra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Nectariniidae and Promerops Caffer.*	Various.	
C. peduncularis..........	Straw or cream; minute	Sweet, rich	‡	—	‡Seeking pollen and nectar	—	—	—	—	Low.
C. buxifolius............	Straw or cream; minute	Sweet, rich	‡	—	‡Seeking pollen and nectar	‡	‡	—	Ants	Medium.
Halleria lucida..........	White, cream, brick-red, scarlet, or light-yellow; one colour per plant	Faint, sweet or nil	‡	—	‡Seeking nectar	‡	‡	‡	Ants Melolonthinae	Medium.
Plectronia spp........... (P. obovata, P. Mundtii, and P. ventosa)	Cream to light straw; minute	Sweet, rich; strong	‡	—	‡Seeking pollen, very rarely nectar	—	—	—	—	Low.
Burchellia capensis......	Scarlet, medium	Nil	‡	—	—	—	‡	‡	—	Medium.
Gardenia Rothmannia....	White, large	Sweet	‡	—	‡Seeking pollen	—	‡	‡	—	Medium.
Royena lucida, R. pallens	Pale, dirty yellow	Sweet, tobacco-like medium	—	—	‡Seeking pollen from males, nectar from females	—	—	—	—	Low.
Euclea spp.............. (E. macrophylla, E. racemosa and E. lanceolata)	White; minute	Sweet; medium	—	—	‡Seeking pollen from males, nectar from females	—	—	—	—	Low.

Table II.—(Continued.)

FLOWERS: KNYSNA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and size.	Odour.	Agents of Pollination.							Degree of Efficient Pollination.†
			Self.	Wind.	Apis mellifica and A. caffra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Nectariniidae and Promerops Caffer.*	Various.	
Sideroxylon inerme......	Cream; minute	Foetid; strong	‡	—	‡Seeking pollen	—	—	—	Diptera Ants	Low.
Rhus laevigata..........	Straw; minute	Faintly sweet or nil	‡	—	‡Seeking pollen	—	—	—	—	Low.
Brachylaena neriifolia....	(Dioecious) white; minute	Sweet	—	‡	‡Seeking pollen from males, nectar from females	—	—	Visit both sexes in search of insects	Diptera Ants Melolonthinae	Medium.
Tarchonanthus camphoratus	(Dioecious) greenish-yellow; minute	—	Nil	—	‡	—	—	—	—	Medium.
Sparmannia africana.....	White, showy, large	Nil	‡	—	‡Seeking pollen	‡	‡	—	Melolonthinae Ants	Low.
Tricholadus crinitis and T. ellipticus (rare and local)	Yellow; minute	Nil	—	‡	‡Occasionally for pollen	—	—	—	—	Low.
Ochna arborea..........	Yellow; showy	Faint, sweet, or nil	‡	—	‡Seeking pollen	—	—	—	Ants	Low.
O. atropurpurea.........	Yellow; showy	Faint, sweet, or nil	‡	—	‡Seeking pollen	—	—	—	Ants	Low.
Lachnostylis capensis....	(Dioecious) greenish; females larger, but minute	Nil	—	‡	—	—	—	—	—	Low.
Ekebergia capensis.......	Greenish-yellow; minute	Faint, sweet, or foetid	‡	—	‡Seeking pollen	—	—	—	Ants	Very low.

Table II.—(Continued.)

FLOWERS: KNYSNA FOREST TREES—COLOUR, ODOUR, POLLINATION.

Species.	Colour and size.	Odour.	Agents of Pollination.							Degree of Efficient Pollination.†
			Self.	Wind.	Apis mellifica and A. caffra.	Anthophora spp. and Xylocopa spp.	Lepidoptera.	Nectariniidae and Promerops Caffer.*	Various.	
Ficus capensis...........	Straw colour, within usual pear-shaped receptacle; minute	Nil	—	—	—	—	—	—	Blastophaga	Very low.
Celtis rhamnifolia........	Greenish-white; minute	Faint, sweet, or nil	‡	—	‡Seeking pollen from hermaphrodite and male flowers	—	—	—	—	Very low.
Pittosporum viridiflorum.	Greenish-white; minute	Sweet; medium	‡	—	‡Seeking pollen	—	—	—	—	Low.
Rhamnus prinoides......	Yellow-green; minute	Faint or Nil	‡	—	‡Seeking pollen	—	—	—	—	Medium.
Scutia Commersonii......	Greenish; minute	Faint or nil	‡	—	‡Seeking pollen	—	—	—	—	Low.

NOTES TO TABLE II.

* Nectariniidae—Cinnyris afer L.
C. chalybeus L.

† Degree of efficient pollination, i.e., of fertilization, based upon proportion of flowers that develop to form fruits.
Very low...... 1–5 per cent. of total number of flowers produced are fertilized.
Low........... 6–20 per cent. of total number of flowers produced are fertilized.
Medium....... 21–40 per cent. of total number of flowers produced are fertilized.
High.......... 41–80 per cent. of total number of flowers produced are fertilized.

‡ Denotes *pollinated by*.

Table III (A).

Nature of the Fruits and Seeds—Cones and Capsules.

Species.	Fruit.	Nature of the Fruit.	Size.	Number of Seeds.	Nature of Seeds.	Amount of Fruit Produced in Full Fruiting Seasons.
Widdringtonia cupressoides	A cone	Woody, valvate; 4-scaled, rounded; greenish-brown; glabrous	$\frac{3}{4}$ inch diameter	4–6	Winged....................................	Medium.
Platylophus trifoliatus	A capsule	Imperfectly dehiscent, membranous, straw-coloured; 2-celled	1/6 × 1/10 inch	2; 2 others aborted	1/15 × 1/30 inch, russet, albuminous........	Very large.
Cunonia capensis	A capsule	Dehiscent, elongated, membranous, brown; 2-celled	$\frac{1}{4} \times \frac{1}{8}$ inch	30–50	Minute, straw-coloured, with slight marginal wings; albuminous; delicate	Very, very large.
Nuxia floribunda	A capsule	Dehiscence septicidal; membranous, straw-coloured; 2-celled	1/6 × 1/8 inch	Numerous	Minute, albuminous; delicate...............	Very, very large.
Chilianthus arboreus	A capsule	Dehiscence septicidal; membranous, straw-coloured, scurfy; 4-valved	1/12 × 1/15 inch	5–15	Minute, elongated, slightly winged in some cases; albuminous; delicate	Very large.
Kiggelaria africana	A capsule	Dehiscing into 3–5 valves; leathery, greenish-yellow, pubescent, and tubercled	$\frac{3}{4}$ inch diameter	15–20	Red-coated; black, shiny within the coat; hard; albuminous	Large.
Trimeria alnifolia	A capsule	3-valved, obovate, leathery..................	1/7 × 1/16 inch	1–3	Minute, pitted, black, albuminous...........	Medium.
Gonioma Kamassi	2 divergent follicles, or mericarps	Leathery or semi-woody, oblong, straight, or curved	$1\frac{1}{2}$–2 × $\frac{1}{2}$ inches	Numerous	Both ends large-winged ($\frac{1}{4}$–$\frac{1}{2}$ inch); variable in size and shape; usually flat; albuminous	Small.
Calodendron capense	A capsule	Dry, woody, angled, tubercled, dehiscing septicidally	1–$1\frac{1}{2}$ inches diameter	4–5	$\frac{1}{2}$ inch diameter, angled, hard, black, shiny, exalbuminous	Very small.
Fagara Davyi	A capsule	Dehiscent into 2 valves, dry, leathery, gland-dotted, acrid	1/8 × 1/16 inch	1	Hard, shiny, black, albuminous.............	Very small.

Table III (A)—(Continued).

Nature of the Ftuits and Seeds—Cones and Capsules.

Species.	Fruit.	Nature of the Fruit.	Size.	Number of Seeds.	Nature of Seeds.	Amount of Fruit Produced in Full Fruiting Seasons.
Pterocelastrus variabilis	A capsule	Semi-succulent, woody, 3-celled, winged, dehiscent	$\frac{1}{3}$–$\frac{1}{4}$ inch diameter	1–3	Hard, shiny, black, within yellow aril, albuminous	Large.
Celastrus acuminatus	A capsule	2-lobed, 2-valved, leathery..................	$\frac{1}{3} \times \frac{1}{4}$ inch	1, rarely 2	Hard, shiny, black, within yellow aril, albuminous	Large.
C. peduncularis	A capsule	Obovata, 2-valved, leathery................	$\frac{1}{3} \times \frac{1}{4}$ inch	1	Hard, shiny, black, within yellow aril, albuminous	Medium.
C. buxifolius	A capsule	3-lobed, 3-valved, leathery to semi-woody....	$\frac{1}{2} \times \frac{1}{4}$ inch	2–3	Hard, shiny, black, within yellow aril, albuminous	Large.
Sparmannia africana	A capsule	Echinate, dehiscing loculicidally; 4–5-celled; leathery, straw-colour	$\frac{1}{3}$–$\frac{1}{2}$ inch diameter	Numerous	Minute, albuminous..........................	Large.
Trichocladus crinitus	A capsule	2-celled, woody, opening violently...........	1/6 × 1/10 inch	2	Cream or yellow, hard, albuminous..........	Large.
T. ellipticus (rare & local)	A capsule	2-celled, woody, opening violently...........	1/6 × 1/10 inch	—	Cream or yellow, hard, albuminous..........	Medium.
Lachnostylis capensis	A capsule	Dehiscing into 6 valves; leathery, greenish to straw-colour	$\frac{1}{2}$–$\frac{3}{4}$ inch diameter	3–6	Black, hard, angular, albumen scanty........	Large.
Pittosporum viridiflorum	A capsule	2-valved, leathery.........................	$\frac{1}{2} \times \frac{1}{3}$ inch	6–8	Reniforme, albuminous, in viscid, transparent resin	Small.
Virgilia capensis	A legume	Dehiscing into 2 valves; membranous, straw-coloured	$1\frac{1}{2}$–3 × $\frac{1}{3}$ inches	—	Very hard, black, exalbuminous.............	Large.

Table III (B). NATURE OF THE FRUITS AND SEEDS—BERRIES AND DRUPES.

Species.	Fruit.	Size.	Description of the Fruits and Seeds. Nature of the Pericarp or Covering.	Colour of the Pericarp or Covering.	Flavour of the Pericarp or Covering.	Number of Seeds (or Endocarps).	Nature of the Seeds (or Endocarps).	Amount of Fruit Produced in Full Fruiting Seasons.
Olea laurifolia.........	Drupe ellipsoid	Inches. $\frac{3}{4}$–1 × $\frac{1}{2}$	Succulent, thick; edible (*)	Dark purple	Bitter-sweet	1	Very hard, bony endocarp with 1 albuminous seed	Very, very large.
O. capensis...........	Drupe, ellipsoid	$\frac{1}{4}$ diam.	Succulent, moderately thick; edible	Dark purple	Bitter sweet	1	Very hard, bony endocarp with 1 albuminous seed	Very large.
O. foveolata..........	Drupe, ellipsoid	$\frac{1}{2}$ × $\frac{1}{4}$	Succulent, moderately thick; edible	Dark purple	Bitter-sweet	1	Very hard, bony endocarp with 1 albuminous seed	Small.
Ocotea bullata........	Drupe, ellipsoid	$\frac{3}{4}$ × $\frac{1}{3}$	Succulent, moderately thick.	Dark purple	Bitter; of Laurin	1	Moderately hard, chitinous endocarp with 1 large, exalbuminous seed	Medium.
Apodytes dimidiata....	Baccate drupe with a red callous heel	$\frac{1}{3}$ × $\frac{1}{4}$	At first very slightly succuent, later, dry; thin	Black; heel red, later grey	Bitter	1	Seed reniforme, with a delicate coat; rich in black albumen	Medium.
Cassinopsis capensis....	Drupe, compressed	$\frac{1}{3}$ × $\frac{1}{8}$	At first semi-succulent, later, dry; thin	Black	Bitter	1	Hard-shelled endocarp with 1 compressed albuminous seed	Small.
Curtisia faginea........	Drupe, globose	$\frac{1}{4}$–$\frac{3}{8}$ diam.	Succulent, later papery; thick	Cream or white, or pink-tinged	Bitter	1 endocarp with 1–4 seeds	Endocarp hard, chitinous, seeds with membranous covers; albuminous	Large.
Olinia cymosa.........	Drupe, globose	$\frac{1}{4}$–$\frac{1}{2}$ diam.	Succulent, thick, remaining fresh over 6 months; edible	Scarlet	Sweet, almond-like	1 endocarp with 1–5 seeds, in viable condition	Endocarp, chitinous, reticulated; seeds in brown membranes, exalbuminous	Very large.
Ilex mitis.............	Drupe, globose	$\frac{1}{4}$ diam.	Succulent, thin............	Scarlet	Bitter	4–6 pyrenes	Seeds, hard 3-sided, albuminous	Large.
Scolopia Mundtii......	Berry, elliptic	$\frac{1}{3}$ × $\frac{1}{6}$	Succulent, moderately thick.	Pink	Sweet; edible	1, rarely 2-seeded	Elongated, albuminous......	Very, very small.
S. Zeyheri............	Berry, elliptic	$\frac{1}{3}$ × $\frac{1}{6}$	Succulent, moderately thick.	Pink	Sweet; edible	1, 2, or 3 seeded	Elongated albuminous......	Very small.
Dovyalis rhamnoides...	Berry, elliptic	$\frac{1}{3}$ × $\frac{3}{4}$	Succulent, moderately thick.	Yellow	Sweet or acid; edible	1–2 seeded	Albuminous................	Small.

Table III (B).— Continued). NATURE OF THE FRUITS AND SEEDS—BERRIES AND DRUPIES.

Species.	Fruit.	Size.	Description of the Fruits and Seeds. Nature of the Pericarp or Covering.	Colour of the Pericarp or Covering.	Flavour of the Pericarp or Covering.	Number of Seeds (or Endocarps).	Nature of the Seeds (or Endocarps).	Amount of Fruit Produced in Full Fruiting Seasons.
		Inches.						
Myrsine melanophleos..	Drupe, globose	$\frac{1}{4}$–$\frac{3}{8}$ diam.	Succulent, moderately thick.	Very dark purple	Bitter	1 endocarp with 1 seed	Hard, bony endocarp with albuminous seed	Very large.
Carissa arduina.......	Berry, elliptic	$\frac{1}{2}$–$\frac{3}{4}$ × $\frac{1}{4}$	Succulent, moderately thick; with latex; edible	Scarlet or pink	Sweet	1, rarely 2	$\frac{1}{2}$ inch long, hard, with horny albumen	Small.
Acokanthera venenata..	Berry, ovoid	$\frac{3}{4}$ × $\frac{1}{2}$	Succulent, thick, with latex. Highly poisonous	Scarlet	? said to be sweet	1 by abortion; 2 rarely	$\frac{1}{2}$ inch long, hard, with horny albumen, but stouter	Large.
Toddalia lanceolata....	Berry, globose	$\frac{1}{8}$–$\frac{1}{4}$ diam.	Leathery, dry, moderately thick	Green to black	Acrid	4	Hard, albuminous..........	Large.
Elaeodendron croceum.	Drupe, ovoid or globose	$\frac{3}{4}$ × $\frac{1}{2}$	Succulent, thick...........	Cream or white	Bitter	1 endocarp with 1 (rarely 2–3) seeds	Seeds fleshy, albuminous....	Medium.
E. capense............	Drupe, ellipsoid	1 × $\frac{1}{3}$	Succulent, thick...........	Cream or white	Bitter	1 endocarp with 1 (rarely 2–3) seeds	Seeds fleshy, albuminous....	Medium.
E. Kraussianum.......	Berry, globose	$\frac{1}{4}$–$\frac{3}{8}$ diam.	Leathery, moderately thick..	Black	Bitter	1–2	Hard, albuminous..........	Small.
Halleria lucida........	Berry, globose	$\frac{3}{8}$–$\frac{1}{2}$ diam.	Fleshy, thick; edible.......	Black	Bitter-sweet, not unpleasant	Numerous	Orbicular or ellipsoid, with narrow membranous wings; albuminous	Very large.
Plectronia obovata.....	Berry, globose	$\frac{1}{4}$ diam.	Semi-succulent; moderately thick	Black	Bitter	2 pyrenes each 1 seeded	Flat, albuminous..........	Medium.
P. Mundtii...........	Berry, didynamous	$\frac{3}{8}$ × $\frac{1}{4}$	Semi-succulent; moderately thick	Black	Sweetish; edible	1 or 2 pyrenes	Flat, albuminous..........	Medium.
P. ventosa...........	Berry, didynamous, pear-shape	$\frac{1}{2}$ × $\frac{3}{8}$	Semi-succulent; moderately thick	Black	Sweetish; edible	1 or 2 pyrenes	Flat, albuminous..........	Medium.
Burchellia capensis....	Berry with long, erect calyx-lobes	Without calyx-lobes, $\frac{3}{8}$ × $\frac{1}{3}$	Leathery, thick...........	Green to brown	Bitter	Numerous	Angular albuminous........	Large.

Table III (B).—(Continued). NATURE OF THE FRUITS AND SEEDS—BERRIES AND DRUPES.

Species.	Fruit.	Size.	Description of the Fruits and Seeds.					Amount of Fruit Produced in Full Fruiting Seasons.
			Nature of the Pericarp or Covering.	Colour of the Pericarp or Covering.	Flavour of the Pericarp or Covering.	Number of Seeds (or Endocarps).	Nature of the Seeds (or Endocarps).	
Gardenia Rothmannia..	Large ovate leathery berry; 1-celled	Inches. 2 × 1	Leathery to woody, costate; thick, with abundant pith	Green, later black	Bitter	Numerous	Horny, with hard albumen; seated on pithy parietal placentae	Medium.
Royena lucida........	Berry, within accrescent calyx	$\frac{1}{2}$ diam.	Semi-succulent, thick.......	Green later brown	Bitter	2–4	Hard, yellowish, oblong, with horny albumen	Large.
Euclea macrophylla....	Apiculate berry	1/5 diam.	Semi - succulent, minutely glandular; moderately thick	Black	Sweet; edible	1	Globular, with 3 impressed lines; albumen horny	Small.
E. racemosa..........	Berry	1/5 diam.	Semi-succulent, moderately thick	Black	Sweet; edible	1	Globular, with 3 impressed lines; albumen horny	Small.
E. lanceolata..........	Berry	$\frac{3}{7}$ diam.	Semi-succulent, moderately thick	Black	Sweet; edible	1	Globular, with 3 impressed lines; albumen horny	Small.
Sideroxylon inerme....	Drupe	$\frac{1}{4}$ diam.	Succulent, with abundant viscid latex; thick	Black	Sweet; edible	1 (endocarp) by abortion, hard	5-lobed, albuminous.........	Large.
Rhus laevigata........	Drupe	$\frac{1}{8}$ diam.	Semi-succulent, moderately thick; sometimes leathery	Reddish	Sweetish; edible	1 endocarp	Endocarp hard; seed exalbuminous	Medium.
Ochna arborea........	3–6 drupes seated on a fleshy torus	Drupes $\frac{1}{4}$–$\frac{3}{8}$ × $\frac{1}{8}$	Drupes: succulent, moderately thick pericarps	Black	Bitter	1 endocarp	Endocarp hard, albuminous, seed	Very small.
O. atropurpurea.......	3–6 drupes seated on a fleshy torus	Drupes $\frac{1}{4}$–$\frac{3}{8}$ × $\frac{1}{8}$	Drupes: succulent, moderately thick pericarps	Black	Bitter	1 endocarp	Endocarp hard; albuminous seed	Very small.
Ekebergia capensis.....	Berry	$\frac{1}{2}$–$\frac{3}{4}$ diam.	Succulent, later leathery; thick	Scarlet	Sweet; edible	2–5 pyrenes	Seeds exalbuminous.........	Large.
Celtis rhamnifolia......	Drupe, ovoid	$\frac{1}{4}$ diam.	Slightly succulent; thin....	Red	Bitter	1	Exalbuminous..............	Small.
Rhamnus prinoides....	Berry	$\frac{1}{4}$ diam.	Succulent, moderately thick.	Black	Bitter	1	Hard, yellow, exalbuminous.	Very large.
Scutia Commersonii....	Berry	$\frac{1}{4}$–$\frac{3}{8}$ diam.	Succulent, moderately thick.	Black	Dry, sweet, edible	3	Elliptic, exalbuminous......	Medium.

Table III (c).

Nature of the Fruits and Seeds—Miscellaneous.

Species.	Fruit.	Description of the Fruit.	Number of Seeds.	Nature of the Seeds.	Amount of Fruit Produced in Full Fruiting Seasons.
Faurea MacNaughtonii............	A long-villous nut with a persistent style	$\frac{1}{8} \times \frac{1}{4}$ inch; brown, leathery, with abundant hairs	1	Yellow, fleshy, exalbuminous	Very, very large.
Brachylaena neriifolia..............	An achene.................	Minute, glandular, with 2 rows of bristly pappus	1	Exalbuminous....	Very, very large.
Tarchonanthus camphoratus........	An achene.................	Minute, woolly, without pappus...............	1	Exalbuminous....	Very large.
Ficus capensis......................	Numerous minute achenes in a fleshy receptacle, or "fig"	Fig: $\frac{3}{4}$–1 × $\frac{1}{2}$ inch; achenes: 1/20 inch; fig: fleshy, sweet, edible. Achenes: hard, membranous, perianth persistent.	1 1	Albumen scanty..	Figs: small. Achenes: very large.
Podocarpus elongata L'Herit.......	Arillate seed (a podocarpium) without a fleshy receptacle	Globose fruit $\frac{1}{2}$–$\frac{3}{4}$ inch diameter, rich yellow; outer layer fleshy, inner, very hard, chininous, tubercled; edible	1	Rich in endosperm	Large.
P. Thunbergii, Hook	Arillate seed (a podocarpium) possessing a succulent, well-developed receptacle	Seed: globose, $\frac{3}{4}$–$\frac{7}{8}$ inch diameter, greenish-purple; outer layer fleshy, resinous; inner layer crustaceous, thin; edible Receptacle: 2-lobed, cherry-red, succulent, $\frac{1}{2} \times \frac{3}{4}$ inch; edible	1	Rich in endosperm	Very large.

NOTE TO TABLE 3 (*b*) AND 3 (*c*).

"Edible" . . . is sought by man; fruits edible for mammals and birds but not for man, are not described as "edible."

Table IV.

Agents of Dispersal.

Wind.	Water.	Birds.	Feral Mammals.	Man.	Various.
Seeds with large membranous wings. (Inefficient as means of dispersal.) Widdringtonia cupressoides. Gonioma Kamassi. *Minute seeds with much-reduced, membranous wings.* (Inefficient as means of dispersal.) Cunonia capensis. *Light membranous capsules not readily dehiscing.* (Very inefficient as means of dispersal.) Platylophus trifoliatus. *Minute seeds with no wings.* (inefficient for wind-dispersal.) Nuxia floribunda, Chilianthus arboreus. Sparmannia africana. *Minute achenes with scant pappus.* (Inefficient as means of dispersal.) Brachylaena neriifolia. *Minute achenes with woolly covering.* (Inefficient as means of dispersal.) Tarchonanthus camphoratus.	*Heavy rains, streams and rivers, rarely the sea.* *Seeds.* Virgilia capensis (by sea) Calodendron capensis (by sea) Lachnostylis capensis (by sea) *Endocarps.* Olea laurifolia. O. capensis. O. foveolata Elaeodendron croceum. E. capense. Olinia cymosa. Curtisia taginea. Sideroxylon inerme (by sea). *Podocarpia.* Podocarpus Thunbergii, Hk. P. elongata, L'Herit (by sea) *Fleshy Berry.* Halleria lucida.	*Principally Doves (Columba arquatrix. Turtur capicola, Chalopelia afra., Haplopelia larvata. "Lourie" Turacus corythaix, "Crowned Hornbill" (Lophoceros melanoleucus), "Amydrus morio" (Red-winged Starling).* Endocarps often ground to pieces by Doves.) Podocarpus Thunbergii. P. elongata. Olea laurifolia (75 removed from 1 dove). O. capensis (over 100 removed from 1 dove). O. foveolata. Elaeodendron croceum. E. capense. Olinia cymosa. Curtisia taginea. Sideroxylone enerme. Ocotea bullata. Ekebergia capensis. ***By** the above birds and by smaller ones, principally Colius striatus, ("Mousebird"); Criolus larvatus, "Geel Kattekreeuw"); Estrilda astrilda, Zosterops capensis, ("Cape White-eye.")* Doygalis rhamnoides. Scolopia Zeyheri. S. Mundtii. Kiggelaria africana. Carissa arduina. Rhamnus prinoides. Scutia Commersonii.	*Seeds or Endocarps passed out in the faces.* *Elephant* (*vide* Phillips, 1925 : 2). Scutia Commersonii. Virgilia capensis. Elaeodendron croceum. E. capense. Olea laurifolia. O. capensis. O. foveolata. Myrsine melanophleos. Olinia cymosa. Podocarpus elongata, L'Herit. *Wild Pig (Potamochoerus choeropotamus).* Podocarpus elongata, L'Herit. Elaeodendron croceum. E. capense. Olea laurifolia. O. capensis. O. foveolata. Myrsine melanophleos. Olinia cymosa. Virgilia capensis. Sideroxylon inerme. Rhus laevigata. Rhamnus prinoides. Plectronia obovata. P. Mundtii. P. ventosa. Ekebergia capensis. *Baboon and Monkey (Choiropithecus porcarius and Cercopithecus pygerythrus.)* All above listed except Virgilia Gardenia Rothmannia.	*Edible Fruits.* Halleria lucida. Olinia cymosa. Olea laurifolia. O. capensis. Scutia Commersonii. Carissa arduina. Sideroxylen inerme. Scolopia Zeyheri. S. Mundtii. Dovyalis rhamnoides. Ficus capensis. Podocarpus elongata, L'Herit. P. Thunbergii, Hook. (taken for sake of the succulent receptacle). Plectronia Mundtii. P. ventosa. Euclea spp.	*Feet and Feathers of Birds and Feet of Mammals.* Cunonia capensis. Chilianthus arboreus. Nuxia floribunda. *Domesticated Birds.* Principally— Olea spp. Olinia cymosa. Podocarpus Thunbergii, Hook. *Dogs.* Olea laurifolia drupes are relished, endocarps are passed out Olinia cymosa, sometimes taken. *Unpalatable Fruits not taken by Birds or Mammals.* Apodytes dimidiata. Cassinopsis capensis. Fagara Davyi. Toddalia lanceolata. Pittosporum viridiflorum *Poisonous Fruit, not taken by Birds and Mammals.* Acokanthera venenata.

Table IV.—(Continued).

AGENTS OF DISPERSAL.

Wind.	Water.	Birds.	Feral Mammals.	Man.	Various.
Densely-villous nut. (Very inefficient for wind-dispersal.) Faurea MacNaughtonii.		Halleria lucida. Ilex mitis. Ochna arborea. O. atropurpurea. Rhus laevigata. Pterocelastrus variabilis (seeds). Celastrus acuminatus (seeds). C. peduncularis (seeds). Elaeodendron Kraussianum. Celtis rhamnifolia. Ficus capensis (seed). Euclea spp. Plectronia obovata. P. Mundtii. P. ventosa. Myrsine melanophleos. Trimeria alnifolia. The endocarps or seeds are either voided in the droppings or regurgitated.	*Bushbuck (Tragelphus sylvaticus), Grijsbuck (Pediotragus tragulus), Bluebuck (Cephalophus monticola).* Podocarpus Thunbergii, Hook. Halleria lucida (seeds). Virgilia capensis (seeds rarely). *Wild Cat (Felis caffra).* Olea laurifolia. O. capensis. O. foviolata. Olinia cymosa. Drupes taken in times of poor hunting. *Fruit Bat (Rousettus collaris).* Olea spp. Ocotea. Olinia. Dovyalis. Scutia. Podocarpus spp.		

Table V.

PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination: normal forest conditions.	Germinative Capacity.*	Principal Agents of Mortality in Fruits and Seeds attaining maturity.	Remarks *re* Fruits and Seeds not attaining maturrity.
Podocarpus elongata L'Herit	6 (rarely)–30 months; generally about 12, removal of succulent covering shortens period	50–80 per cent.....	*Ceratitis capitata* larvae sometimes destroy embryo; Lepidopterous larvae often destroy embryo. Destroyed by wild pig and bats.	Wind-blown; knocked off by birds and bats.
P. Thunbergii Hook......	2–4 months; generally 2½..........	Variable, 20–80 per cent, but usually 50–60 per cent.	*Ceratitis capitata* larvae damage a fair number of embryoes; *Corynelia uberata* Fr. often destroys 20–50 per cent. of the embryoes. Lepidopterous larvae destroy a fair number ef ombryoes. Destroyed by wild pig and bats, also by doves.	*Corynelia uberata* prevents development of large proportion of young fruits; others are dislodged by wind, birds, and bats
Widdringtonia cupressoides	1½–3 weeks..........................	60–70 per cent.....	Some seeds are very poorly developed, being small and light, these do not germinate; small Curculionidae destroy others	Practically all seeds attain maturity.
Olea laurifolia...........	6–18 months; usually 12; removal of pericarps appreciably decreases the period. Endocarps passed through wild pig and bushdove germinate in 4–6 months	50–80 per cent.....	*Ceratitis capitata*, *Munromyia nudiseta*, and *Afrodacus biguttulus* destroy many embryoes. A Lepidopterous larva destroys a few. Wild pig, bushdove, destroy many endocarps	Approximately 75 per cent. of the fruit crop of each tree falls prematurely owing to (1) fungus (Hysteriaceae) attacking fruit-stalks; (2) disturbance caused by Bushdoves and Turacus; (3), heavy wind.
Olea capensis...........	6–36 months; usually 9–12; removal of the pericarps appreciably decreases the preiod. Endocarps passed through wild pig and bushdove germinate in 4–6 months	40–60 per cent.....	*Ceratitis capitata* destroys many embryoes. Wild pig and bushdove destroy many endocarps	Approximately 50 per cent. of the fruit crop of each tree falls prematurely owing to (1) disturbance caused by bushdoves and Turacus (2) heavy wind.
Olea foveolata...........	6–12 months; remarks as for *Olea capensis*	50–60 per cent.....	*Ceratitis capitata*, *Munromyia nudiseta*, *Afrodacus biguttulus*, destroy large numbers of embryoes. Wild pig and bushdoves destroy many endocarps	do. do.

Table V.—(Continued).

PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination: normal forest conditions.	Germinative Capacity.*	Principal Agents of Mortality in Fruits and Seeds attaining maturity.	Remarks *re* Fruits and Seeds. not attaining maturity.
Ocotea bullata.........	1–2 months; bird-voided endocarps usually require 3–4 weeks	0·01–1 per cent....	*Ceratitis capitata* and the larva of a small moth destroy large numbers of the embryoes. The bulk of the destruction, however, is due to *Pestalozzia n. sp.*, *Fusarium spp.* attack fallen, mature fruits. Bats and wild pig destroy many endocarps	Wind, birds, and bats knock down over 5 per cent. of the crop of each tree, before its maturity; these fallen fruits are attacked by insects, fungi, and destroyed by wild pig.
Apodytes dimidiata......	1½–3 months......................	Very variable; 50–70 per cent. in some crops, only 10–20 per cent. in others	Lepidopterous larva destroys many embryoes; *Ceratitis capitata* sometimes destroys a fair number. Small Curculionidae destroy others	Many fruits fall prematurely on account of severe winds.
Cassinopsis capensis......	3–4 months......................	70–80 per cent.....	A few fruits are destroyed by various insects	Very few fruits fall prematurely.
Curtisia faginea.........	6–12 months; removal of the succulent pericarp lessens period	40–50 per cent.....	Dipterous and Lepidopterous larvae destroy destroy many embryoes; many seeds decay before bony endocarp allows of their escape. Bats, wild pig and bushdoves destroy many endocarps	Many fruits are very poorly developed owing to gall-forming oragnism in the flowers.
Platylophus trifoliatus...	1–3 months......................	2–4 per cent.	Capsules do not allow of ready escape of the seeds, which may thus decay before capsule-walls have broken down *Zosterops capensis* ("Cape White-eye") destroys numbers of the seeds. Fallen mature capsules are destroyed in considerable numbers by wild pig.	The overwhelming majority of seeds does not develop to maturity despite the formation of large, healthy capsules.
Cunonia capensis........	1–3 months......................	2–5 per cent.......	The larger proportion of the capsules fall in moist or fern-clad sites, and into water, they thus readily decay. Millions of seed fall upon leaning tree-trunks, tree-fern tops, mossy stones, etc., and either decay before germination, or produce 1-several-day-lived seedlings only. *Zosterops capensis* and *Estrilda astrilda* ("Swee") destroy thousands of seeds.	Whole fruit-bearing spikes are blown by wind ere they are mature; many capsules are destroyed by birds.
Nuxia floribunda........	1½–3 months......................	Less than 1 per cent.	Millions of the seeds share the same fate as those of Cunonia as above described. A *Fusarium sp.* causes decay in large numbers of fallen fruits. Large numbers are under-developed, with small embryoes.	Fruiting panicles are blown by the thousand, ere the fruits are mature.

Table V.—(Continued).

PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination: normal forest conditions.	Germinative Capacity.*	Principal Agents of Mortality in Fruits and Seeds attaining maturity.	Remarks *re* Fruits and Seeds not attaining maturity.
Chilianthus arboreus.....	1½–2 months........................	Less than ½ per cent.	Millions fall upon ground unsuitable for germination, and decay. Coleoptera destroy large numbers of the seeds, and various fungi claim many others	Fruiting panicles are blown by the thousand, ere the fruits are mature.
Olinia cymosa...........	Varies according to locality: may lie dormant for 24–40 months, or may germinate within 12–18 months	8–12 per cent......	Hard, chintinous endocarp takes many months to decay, the small white, delicate embryo is not supplied with food-reserves, and often decays ere it is able to put out its radicle. Large numbers of under-developed embryoes occur. *Ceratitis capitata* destroys a small number of seeds.	Wind, birds, bats dislodge thousands of immature fruits.
Ilex capensis............	2–4 months........................	40–60 per cent.....	Dipterous and Lepidopterous larvae destroy a number of seeds. Wild pigs destroy many fallen fruits.	do. do.
Kiggelaria africana......	1½–3 months........................	70–80 per cent.....	Dipterous larvae destroy a number of seeds	do. do.
Scolopia Mundtii........	2–3 months........................	40–50 per cent.....	Dipterous and Lepidopterous larvae destroy large numbers of seeds. Wild pigs destroy many fallen fruit.	do. do.
S. Zeyheri..............	2–3 months........................	50–60 per cent.....	do. do.	do. do.
Trimeria alnifolia........	1½–2 months........................	60–70 per cent.....	Dipterous larvae do some harm..........	The compact fruiting spikes are blown in large number ere mature
Dovyalis rhamnoides.....	2–3 months........................	70–80 per cent.....	*Ceratitis capitata* accounts for some of the embryoes	Wind, birds, bats cause premature fall of many fruits.
Myrsine melanophleos....	2–4 months........................	40–60 per cent.....	*Corynelia fruticola* destroys many fruits; *Ceratitis capitata* does some damage	*Corynelia* inhibits the development of large numbers of young fruits
Faurea MacNaughtonii...	1½–3 months........................	½–1 per cent.......	No diseases known; seeds very poorly developed despite size of the fruits	Large numbers of nuts fall prematurely owing to strong winds
Virgilia capensis.........	unless stimulated by heat or bruised, the seeds remain dormant for many years [*vide* Phillips, J. F., 1926 (4)]; on stimulation, germination takes place within 7–21 days	99–100 per cent....	No diseases known	A small number of legumes is blown by wind ere maturity.

Table V.—(Continued).

PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination: normal forest conditions.	Germinative Capacity.*	Principal Agents of Mortality in Fruits and Seeds attaining maturity.	Remarks *re* Fruits and Seeds not attaining maturity.
Gonioma Kamassi......	1–2 months......................	30–40 per cent.....	Curculionidae destroy some seeds; many seeds very poorly developed. Seeds readily destroyed by water.	Follicles often fall prematurely.
Carissa arduina.........	$1\frac{1}{2}$–$2\frac{1}{2}$ months....................	20–30 per cent.....	*Ceratatis capitata* and other Dipterous larvae destroy many seeds	Many fruits fall prematurely.
Acokanthera venenata...	4–5 months......................	80–90 per cent.....	No diseases known; some seeds underdeveloped	A few fruits fall prematurely.
Calodendron capense....	8–16 months.....................	80–90 per cent.....	No diseases known; some seeds underdeveloped	A few fall prematurely.
Toddalia lanceolata......	3–4 months......................	70–80 per cent.....	No diseases known. Some seeds are poorly developed	Large numbers are blown by wind before maturity.
Fagara Davyi...........	3–4 months......................	60–70 per cent.....	Large numbers of poorly developed seeds; no diseases known	do. do.
Pterocelastrus variabilis...	$2\frac{1}{2}$–3 months.....................	60–70 per cent.....	Dipterous larvae destroy fair numbers of seeds; fallen seeds sometimes attacked by *Fusarium sp.* which sets up decay	A few fruits fall prematurely.
Elaeodendron croceum...	12–30 months; removal of the pericarp appreciably decreases the period	70–80 per cent.....	Dipterous larvae destroy a small number of seeds; Lepidopterous larva claims a few; endocarps that remain on soil for a long period are subject to decay through various fungi.	Birds and bats dislodge a fair number of drupes.
E. capense.............	do. do.	do. do.	do. do.	do. do.
E. Kraussianum.........	4–5 months......................	50–70 per cent.....	Many seeds are under-developed; Dipterous and Lepidopterous larvae destroy fair numbers	Only a few fruit fall prematurely
Celastrus acuminatus.....	$2\frac{1}{2}$–$3\frac{1}{2}$ months....................	50–60 per cent.....	do. do.	Many fall prematurely.
C. peduncularis..........	3–4– months.....................	60–70 per cent.....	do. do.	do. do.
C. buxifolius...........	3–4 months......................	70–80 per cent.....	A small number is underdeveloped; a small number is destroyed by larvae of Diptera	do. do.
Halleria lucida..........	2–3 months......................	85–90 per cent.....	No diseases of seed known. A few seeds are underdeveloped	The larger portion of each crop falls prematurely

Table V.—(Continued).

PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination : normal forest conditions.	Germinative Capacity.*	Principal Agents of Mortality in Fruits and Seedsattainingmaturity.	Remarks *re* Fruits and Seeds. not attaining maturity.
Plectronia obovata.......	$2\frac{1}{2}$–3 months........................	50–60 per cent.....	Dipterous larvae destroy many seeds....	Many fall prematurely.
P. Mundtii..............	2–3 months........................	40–50 per cent.....	Dipterous larvae destroy many seeds. Wild pig and doves destroy many	do. do.
P. ventosa..............	2–3 months........................	30–50 per cent.....	do. do.	do. do.
Burchellia capensis......	3–4 months, if seeds are removed from tough-coated berry ; 6–8 months if berry be left undisturbed	40–50 per cent.....	Large numbers of the seeds are under-developed	Very few fruits fall prematurely.
Gardenia Rothmannia.....	$3\frac{1}{2}$–$4\frac{1}{2}$ months, if seeds are removed from pithy fruit ; 9–12 months if fruit be left undisturbed.	70–80 per cent.....	Many seeds are attacked by Mould-fungi during drying-out process of the large fruit. Curculionidae destroy some seeds. A few seeds are destroyed by baboons which steal the fruits	Baboons dislodge and destroy many green fruits.
Royena lucida...........	3–4 months........................	35–45 per cent.....	*Ceratitis capitata* destroys large proportion of fruits	Wind and baboons dislodge many fruits.
Euclea macrophylla......	$3\frac{1}{2}$–$4\frac{1}{2}$ months......................	50–60 per cent.....	Many seeds are under-developed ; Dipterous larvae destroy many	A few fall prematurely.
E. racemosa............ E. lanceolata............		40–50 per cent..... 40–50 per cent.....	do. do. do. do.	
Soderoxylon inerme......	4–6 months........................	75–80 per cent.....	*Ceratitis capitata* destroys a large proportion Wild pigs destroy many fallen fruits	Birds dislodge large numbers of fruits.
Rhus laevigata..........	3–4 months.................	40–50 per cent.....	Dipterous larvae destroy a large number.	Birds and wind dislodge large numbers of fruit.
Brachylaena neriifolia....	1–$1\frac{1}{2}$ months......................	10–20 per cent.....	A large proportion of embryoes is under-developed ; water acts detrimentally upon others ; the glandular achenes are destroyed by moulds, by Dipterous larvae and by Curculionidae.	The larger proportion of achenes is blown prematurely.
Tarchonanthus camphoratus	2–3 months ; if woolly covering remains in place, the period may be 6–9 months—until such covering has decayed	20–30 per cent.....	A large number of achenes do not escape from woolly coverings ere the embryoes have perished; Curculionidae, Lepidopterous larvae, and moulds destroy large numbers of achenes.	A large number is blown prematurely.
Sparmannia africana.....	3–5 months........................	40–50 per cent.....	A large number is under-developed ; Fusarium spp. and moulds destroy others. Water assists in rapid decay	A large number is blown prematurely.

Table V.—(Continued).

PERIOD REQUIRED FOR GERMINATION—GERMINATIVE CAPACITY—AGENTS OF MORTALITY IN FRUITS AND SEEDS.

Species.	Average period required for germination : normal forest conditions.	Germinative Capacity.*	Principal Agents of Mortality in Fruits and Seeds attaining maturity.	Remarks *re* Fruits and Seeds not attaining maturity.
Trichocladus crinitus.....	2½–3½ months......................	80–90 per cent.....	Curculionidae destroy a few............	A few seeds fall ere maturity.
T, ellipticus (rare and local)	do.	60–70 per cent.....	do.	do.
Ochna arborea..........	3–4 months........................	30–40 per cent.....	*Ceratitis capitata*, other Dipterous larvae, Leopidopterous larvae, and Curculionidae do much damage	A large number falls ere maturity
O. atropurpurea..........	3–4 months........................	20–30 per cent.....	do. but more severely. Many seeds are under-developed	do. do.
Lachnostylis capensis....	4–5 months........................	60–70 per cent.....	A fair number of seed is under-developed. No diseases knowm.	A few seeds fall prematurely.
Ekebergia capensis.......	2½–4 months; removal of the pericarp decreases the period	40–50 per cent.....	*Ceratitis capitata* does much damage; Curculionidae also destroy many embryoes; fruits lying on soil in moist sites are destroyed by moulds. Wild pigs destroy some seeds.	A fair number is blown prematurely some fruits are removed by birds and bats.
Ficus capensis...........	2–3 months . . . if receptacle dries round the seeds, the period is increased by several months—until the receptacle has decayed.	10–20 per cent.....	The receptacle is attacked by larvae of Diptera, and Lepidoptera, and by birds—many seeds being destroyed by these means. Many seeds are pöorly developed, many other are attacked by moulds	A large number of "figs" falls prematurely.
Celtis rhamnifolia........	2½–3½ months......................	30–40 per cent.....	Dipterous larvae and Curculionidae do much damage	A small number falls prematurely.
Pittosporum viridiflorum	3–5 months........................	80–90 per cent.....	No diseases known......................	Very few seeds fall prematurely.
Rhamnus prinoides......	4–6 months; removal of the pericarp assists germination	80–90 per cent.....	Dipterous larvae sometimes present; some seeds are under-developed. Fallen fruits sometimes destroyed by wild pig	do. do.
Scutia Commersonii......	3–5 months; removal of the pericarp assists germination	70–80 per cent.....	Some seeds under-developed............	Birds, bats, wind dislodge fair numbers

NOTE TO TABLE 5.

*GERMINATIVE CAPACITY.

The proportion of viable or germinable seed per 100 ; in Nature *the percentage that actually germinates* is always infinitely lower than the *germinative capacity*, owing to community, and habitat, conditions, pathogenic fungi and destructive insects, birds, and mammals.

The term is used by Bates (1913) and has the same meaning as "*germination number*" of H. Mayr (1910), and other German authors, and as "*final germination percentage*', of I. S. Boyce (1915).

The germinative capacity is established by (*a*) examination of dissected fruits and seeds (*b*) germination tests.

Table VI.

QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season: Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors Causing Mortality.
Podocarpus elongata L' Herit	Local; under some female trees 100 to 200 seedlings (from several days to several months old) per square metre are found. Usually produced in vigorous condition	Fair, but varying with season	*Fusarium* spp. kill large numbers; *Pestalozzia* sp. nov. kills scattered plants.
Podocarpus Thunbergii, Hook	Extremely abundant—under many trees as many as 100 to 300 seedlings (of several days to several months) per square metre. A small proportion of the plants are produced with desease (Fusarium) but the majority are vigorous	High..............	*Fusarium* spp. kill off many thousands of young seedlings.
Widdringtonia cupressoides	Locally frequent; usually produced in vigorous condition..........	Very low..........	*Fusarium spp.* "damp off" a small number in moister sites.
Olea laurifolia...........	Extremely large numbers of seedlings are produced: under many trees as many as 500 seedlings (cotyledon-stage) per square metre are found. Owing to bird and mammal agency seeds often germinate in localities where no parents exist. Seedlings are delicate in rare instances only—usually they are very vigorous, if not attacked by diseases. The majority, soon after appearance, are attacked by the diseases mentioned under mortality factors	Very high; some sites are known to have lost 200 to 300 plants per square metre in several months	Chief diseases described in the writer's 1923 paper, q.v. *Perisporiaceae* and *Microthyriaceae* do some harm; *Corticium vagum* accounts for large numbers; *Fusarium spp.* "damp off" many plants just emerging from the endocarps. *Coccidae* kill the majority of 2–8 week old plants.
Olea capensis...........	Scattered seedlings appear throughout the forests, but are more abundant on open sites and along the margins. Occasional communities showing 100–200 seedlings per square metre are found. Produced vigorous and disease-free	Fair..............	As for above sp., but their influence is less severe.
Olea foveolata...........	Scattered seedlings only—seldom frequent. Produced in vigorous and disease-free condition	Low..............	As for Oleo laurifolia, but their influence is very slight.
Ocotea bullata..........	Always a few seedlings appear throughout the better portions of the Forests where dense layer-societies of shrubs, herbs, and ferns are either absent or sparse. Seedlings are exceptionally delicate when produced, but are always disease-free	Fair in plants under 12 months; slight in older	*Morenoella Phillipsii Dge.* kills off young plants. Older plants are attacked by the pith-boring larva of an unidentified Beetle, the life-history of which has not yet been studied to completion; some of the bored plants die, but many die-back and re-shoot.
Apodytes dimidiata......	Variable; some sites show from 50 to 200 plants per square metre, others show none. Plants are delicate but disease-free on first appearance	Very high, in youngest stages	*Fusarium spp.* kill a large proportion of the seedling-crop. The "Blue-buck" (*Cephalophus monticola*) browses off very large numbers of younger and older plants.

21 *Table VI.*—(Continued).

QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season: Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors Causing Mortality.
Cassinopsis capensis......	Far scattered, rarely in communities of more than 2 plants per square metre. Always vigorous and disease-free	Very low..........	Diseases unknown.
Curtisia faginea.........	Large numbers are produced, often 100 to 200 per square metre; always vigorous and disease-free on first appearance	Fair..............	*Fusarium spp.* do much damage. *Meliola ganglifera* (*Perisporiaceae*) kills many seedlings of 3 to 9 months of age.
Platylophus trifoliatus	Usually very rare; on occasion locally fair; rarely as many as 50 plants per square metre under parents growing in best, *sylviculturally-treated sites.* Plants are delicate on first appearance, but are disease-free	Very low..........	Practically no biotic enemies. Physical factors of unfavourable nature, however, do more harm. (*Vide* J. F. Phillips 1925: i.).
Cunonia capensis.........	Very large numbers—many millions of minute seedlings wherever parents are plentiful; over 3,000 plants per square metre in many instances. Plants are exceedingly small and very delicate on first appearance, and are attacked by *Fusarium spp.* as soon as they put forth radicles	Very high in first stages, slight in stages older than 6 months	*Fusarium* spp. do very great harm, killing off the greater part of the young plants. Large numbers are destroyed by birds (*Cossypha caffra*, *C. bicolor*: "Robins.")
Nuxia floribunda.........	Large numbers, usually scattered as to area; locally dense seedling communities are occasionally found. Plants on first appearance are small but disease-free	Fair..............	*Fusarium spp.* kill off large numbers of the first stage plants, and *Meliola Hendeloti* a fair number of the older ones
Chilianthus arboreus.....	Very occasional; vigorous and disease-free......................	Very low..........	*Capnodium spp.* cover foliage of some young plants and slowly kill off the leaves.
Olinia cymosa...........	Fair numbers locally, but in general, scattered or rare. Appearance of regeneration after fall of fruits is very long delayed [*vide* Phillips 1926 (i)]—it being from 12 to 24 months ere germination takes place. Seedlings very delicate	High..............	*Fusarium*, *Capnodium spp.* do a little damage *Asterina reticulata* less. Unfavourable physical factors do much harm.
Ilex capensis............	Fairly large numbers of young plants are to be found under parent trees; plants are vigorous and disease-free on first appearance	Slight.............	*Englerulaster orbicularis* (*Microthyriaceae*) kills a small number of seedlings.
Kiggelaria africana......	Fair quantities are produced, but the plants are usually well scattered. They are vigorous and fast-growing from the very beginning, and are disease-free	Slight............	*Fusarium spp.* kill a small number of the youngest plants; the older plants sometimes suffer from attacks of the larva of *Affraeia horta* (*Lepidoptera*).
Scolopia Mundtii........	Rare; vigorous and disease-free.................................	Very low.........	No diseases known.

Table VI.—(Continued).

QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season: Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors Causing Mortality.
S. Zeyheri	Rare; vigorous and disease-free	Very low	*Capnodium spp.* do some harm to foliage of some young plants.
Trimeria alnifolia	Occasional; vigorous and disease-free	Low	No diseases known.
Dovyalis rhamnoides	Very occasional; vigorous and disease-free	Very low	*Capnodium spp.* do some harm to foliage of some young plants.
Myrsine melanophleos	Very large numbers are found near parent trees—as many as 1,000 to 1,500 first-stage plants may be found per square metre. Seedlings occur in Macchia, whither the seeds have been borne by birds. The plants are vigorous on first appearance, but develop badly-shaped stems and root-systems; they are liable to early fungus attack	High	*Fusarium spp.* and *Pestalozzia sp. nov.* kill off many thousands of first-stage plants.
Faurea McNaughtonii	Very large numbers produced under parent trees, absolutely no plants in Forest where parents do not occur. As many as 50 to 100 plants, first-stage, may be found per square metre, under or adjacent to parent-trees. Plants are vigorous and fast-growing from the beginning	Slight	No biotic diseases are known, apart from the slight harm caused by *Hysterostoma Faureae* (*Polystomellaceae*).
Virgilia capensis	If soil containing the hard seeds is distributed by trampling, cultivation, or fire, germination of *Virgilia* is excellent; seed not stimulated remains dormant for over 30 years. As many as 1,000 seedlings per square metre are found on burnt ground that contained germules of the sp.	Very high	*Peronospora sp.* and *Fusarium spp.* kill very large numbers of first-stage plants. The larva of *Euxoa segetis Schiff. sp* (*Lepidoptera*) ("Cut-worms") do considerable damage. *Mice* and *Voles* eat off thousands of later-stage plants. "Bluebuck" (*Cephalophus*) also do much harm.
Gonioma Kamassi	Rare; occasionally locally-frequent; vigorous, disease-free	Slight	No biotic diseases are known.
Carissa arduina	Very occasional; vigorous and disease-free	Very low	*Capnodium spp.* do some harm to foliage of some young plants.
Aconkanthera venenata	Occasional; vigorous and disease-free	Very low	No diseases known.
Calodendron capense	Rare; scattered; vigorous and disease-free	Very low	No diseases known.
Toddalia lanceolata	Very occasional; locally frequent. Vigorous and disease-free	Low	*Fusarium spp.* "damp off" a few plants; "Bluebuck" browse a few.

Table VI.—Continued.)

QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season: Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors Causing Mortality.
Fagara Davyi..........	Rare; tender in earliest stages, hardy in later....................	Low...............	No diseases known.
Pteroceelastrus variabilis..	Very fair numbers of seedlings are produced; vigorous and disease-free on first appearance	Low...............	*Fusarium spp.* "damp off" a small number of first-stage plants; *Capnodium spp.* harm foliage of older ones.
Elaeodendron croceum...	Frequent; hardy and slow-growing, disease-free..................	Medium...........	*Asterodothis solaris* (Dothideaceae) kills a large number of plants of various ages. *Fusarium spp.* "damp-off" first-stage seedlings.
E. capense.............	Frequent; hardy and slow-growing, disease-free, on first appearance	Medium...........	*Asterodothis solaris* (Dothideaceae) kills a large number of plants of various ages. *Fusarium spp.* "damp-off" first-stage seedlings.
E. Kraussianum.........	Occasional; vigorous and disease-free on first appearance.........	Low...............	*Capnodium spp.* kill off some plants
Celastrus acuminatus....	Occasional; locally-abundant; vigorous and disease-free on first appearance	Low...............	*Fusarium spp.* "damp off" some young plants; some killed by *Capnodium spp.*
C. peduncularis.........	Occasional; locally-abundant; vigorous and disease-free on first appearance	Low...............	*Fusarium spp.* "damp off" some young plants; some killed by *Capnodium spp.*
C. buxifolius...........	Frequent; vigorous and disease-free on first aapearance...........	Low...............	Youngest plants often "damped off" by *Fusarium spp.*
Halleria lucida..........	Abundant; vigorous and disease-free on first appearance..........	Low...............	Many plants are browsed by "Bluebuck."
Plectronia obovata......	Occasional; vigorous and disease-free on first appearance.........	Low...............	*Meliola falcata* kills a few first-stage plants.
Plectronia Mundtii.......	Frequent; vigorous and disease-free on first appearance...........	Low...............	Browsed by "Bluebuck"; in moist sites *Fusarium spp.* "damp off" a few first-stage plants.
P. ventosa.............	Occasional; vigorous and disease-free on first appearance.........	Low...............	*Capnodium spp.* kill a few seedlings.
Burchellia capensis......	Abundant; vigorous and disease-free on first appearance..........	Low...............	"Bluebuck" browse off fair numbers of young plants.
Gardenia Rothmannia....	Occasional; usually scattered; vigorous and disease-free on first appearance	Low...............	No diseases known.

Table VI.—(Continued.)

QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season: Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors Causing Mortality.
Royena lucida..........	Abundant; vigorous and disease-free on first appearance..........	Low...............	*Capnodium* and *Fusarium spp.* destroy a small number of first-stage pants.
Euclea macrophylla......	Very occasional; vigorous and disease-free on first appearance.....	Low...............	No diseases known.
E. racemosa............	Very occasional; vigorous and disease-free on first appearance.....	Low...............	No diseases known.
E. lanceolata...........	Very occasional; vigorous and disease-free on first appearance.....	Low...............	No diseases known.
Sideroxylon inerme......	Rare; vigorous and disease-free on first appearance...............	Low...............	No diseases known.
Rhus laevigata..........	Rare; vigorous and disease-free on first appearance...............	Low...............	Sought by "Bluebuck" and "Grijsbuck" (*Pediotragus tragulus*).
Brachylaena neriifolia....	Occasional—along river beds; vigorous and disease-free on first appearance	Low...............	No diseases known.
Tarchonanthus camphoratus	Rare; occasional in littoral bush; vigorous and disease-free on first appearance	Low...............	No diseases known.
Sparmannia africana.....	Abundant; often appearance in diseased condition................	Medium...........	Large numbers are "damped off" by *Fusarium spp.*; *Euxoa segetis* (Cutworm) destroys fair numbers.
Trichocladus crinitus.....	Frequent; vigorous and disease-free on first appearance...........	Low...............	Bucks browse off large numbers in some localities.
T. ellipticus (rare and local)	Rare; vigorous and disease-free on first appearance...............	Low...............	Bucks do some harm.
Ochna arborea..........	Occasional, far scattered; vigorous and disease-free on first appearance	Low...............	No diseases known.
O. atropurpurea.........	Very occasional, and local; vigorous and disease-free on first appearance	Low...............	No diseases known.
Lachnostylis capensis....	Frequent; vigorous and disease-free on first appearance...........	Low...............	No diseases known.
Ekebergia capensis......	Abundant; tender on first appearance, and sometimes diseased....	High..............	*Fusarium spp.* kill off large numbers of first-stage plants; *Euxoa segetis* (Cutworm) takes heavy toll. Buck browse larger seedlings.
Ficus capensis...........	Rare; vigorous and disease-free on first appearance...............	Low...............	No diseases known.

Table VI.—(Continued.)

QUANTITY OF NATURAL REGENERATION AND PRINCIPAL BIOTIC MORTALITY FACTORS.

Species.	Usual Amount and Condition of Young Regeneration Following a Full Fruiting Season: Normal Forest Localities.	Degree of Mortality.	Principal Biotic Factors Causing Mortality.
Celtis rhamnifolia........	Rare; vigorous and disease-free on first appearance..............	Low..............	*Fusarium spp.* take toll of youngest plants.
Pittosporum viridiflorum.	Rare; vigorous and disease-free on first appearance..............	Low..............	No diseases known.
Rhamnus prinoides......	Abundant; vigorous and disease-free on first appearance..........	Low..............	Buck destroy some plants.
Scutia Commersonii......	Occasional; vigorous and disease-free on first appearance..........	Low..............	Buck destroy some plants.

Appendix II.

THE
BEHAVIOUR OF ACACIA MELANOXYLON R. Br.
("Blackwood")
IN THE FORESTS OF THE KNYSNA.

[*Vide* Phillips, 1928; (1).]

THE BEHAVIOUR OF *ACACIA MELANOXYLON* R.BR. ("BLACKWOOD") IN THE FORESTS OF THE KNYSNA.*

Introductory Remarks.

Some interesting and important features of ecological, sylvicultural and economic nature are brought to light in the study of the behaviour of the exotic *Acacia melanoxylon* R.Br., in the indigenous forests of the Knysna. The objects of the present communication are to describe briefly observations and experiments connected with the behaviour of the species under study, and to outline the conclusions drawn as a result of the investigations.

Brief History of Introduction.

So far as the writer has been able to trace, the species was introduced to the George-Knysna-Zitzikama region at about the same time as the "Blue Gum" (*Eucalyptus globulus*)—1856. Captain Harison, the first Conservator of the George-Knysna-Zitzikama forests, in 1874 wrote that large trees of the species were to be found in the gardens of Knysna village. From other references in Harison's correspondence it seems that the "Blackwood" had been extensively planted in the gardens at George.

As the Colonial Secretary in 1876 pressed for the planting of "burns" and other gaps in the forests, and urged the extension of the limits of the indigenous forests by means of exotics, Harison obtained supplies of "Blackwood" seed from McGibbon, Curator of the Government Gardens, Capetown. The Conservator commenced raising the species in his own garden at Concordia. Ere the young plants were large enough to be transplanted to the forest or macchia, Roland Trimen published a note on the "Australian Bug," reputed to be a severe pest of "Blackwood." Harison immediately grew sceptical as to the advisability of planting so susceptible a species and for the time being checked his planting operations. His fears evidently were well-founded, for in March, 1877, the insect actually did appear on "Blackwood" in the village and environs of George. Harison so much feared that the indigenous forest trees would become infected, that he issued stringent orders to the Forest Rangers *re* the felling and burning of all suspicious-looking trees, exotic and indigenous alike. So great was the alarm caused by the outbreak, that no further attention was paid to the planting of "Blackwood" until 1889, when D. E. Hutchins, Conservator of Forests at Knysna, planted it on a small scale as "live" fire-belt. He was succeeded in this work by Conservator Cooper in 1890. Comparatively few trees were planted in these 1889-1891 operations, and such almost entirely along the forest margins. Indeed it may be said that until 1909 no serious attempt to introduce "Blackwood" to the forests proper had been made.

In 1909 J. S. Henkel, then Conservator of Forests at Knysna, referring to the natural regeneration of the indigenous forests and the inter-planting of these forests with exotics, wrote (Annual Report, Chief Conservator of Forests, for 1909, p. 17):—" . . . . . There are profound relationships existing between species which it is essential to maintain in order to produce the best results. It is, however, possible that, by the introduction of exotics, the natural process of regeneration may be accelerated and a quicker return

* *Vide* Phillips 1928; (1)

obtained by a judicious introduction of a faster growing species. Much thought has been given to this subject and interesting examples of success have been discovered. A remarkable case at White Els Bush may be quoted. It would appear that, either by accident or design, a single blackwood tree (*Acacia melanoxylon*) was introduced into the forest. The original tree is standing, though somewhat injured by fire. From this tree, radiating in all directions, an excellent group of well-grown blackwoods has been produced. In some cases the dense canopy of indigenous trees has been pierced by the vigorous blackwoods. This has been done without any assistance from man and notwithstanding a dense growth of weeds. . . . ."

From about 1910 until 1922 the planting of gaps in exploited forest received some attention, while living belts were formed round the margins of a number of forests. A very large proportion of the seedlings and root-suckers planted was either killed or seriously damaged by Elephant, Bushbuck (*Tragelephus sylvaticus*), Grijsbok (*Pediotragus tragulus*), Bluebuck (*Cephalophus monticola*), Wild Pig (*Potamochoerus choeropotamus*), and Cattle.

THE BEHAVIOUR OF *ACACIA MELANOXYLON* R.BR.

I. General Observations.

Apparently the objects of the introduction of "Blackwood" into the exploited portions of the indigenous forests have been (*a*) the subjugation of the rampant weeds following excessive removal of the upper canopy on one and the same site, (*b*) acceleration of the process of natural regeneration of indigenous species.

During examination of various portions of the Deepwalls forests in 1922-1923, and of the Gouna and Sourflats forests in 1923, it was noted repeatedly that "Blackwood" had in most instances fulfilled the first duty expected of it—killing off of weeds such as *Helichrysum petiolatum*, *H. parviflorum*, *Plectranthus fruticosus*, and *Rubus* spp. So far from assisting in the processes of establishment, growth, and development of natural regeneration of the native trees, it appeared actually to retard these processes. Regeneration of native species was not only very, very rare under stands of *Acacia melanoxylon*, but also appeared non-assertive and moribund.

Two reasons for this poverty of regeneration were thought likely to exist: (*a*) the "Blackwood" when planted close together (4×4, 6×6, or even 8×8 feet) on small clearings in the forest, *reduced the Light-intensity so considerably that native seedlings were unable to establish themselves, or, if they were able to establish themselves, were unable to develop normally;* (*b*) the "Blackwood" *drew so strongly upon the supply of soil moisture that regeneration of the relatively delicate native species was unable to establish itself, or at all events to develop.*

With these as *hypotheses*, the writer set out to test by definite experiment their *veracity and relative importance.*

II. The Reaction of *Acacia Melanoxylon* R.Br. on the Light-intensity.

The Light-intensity at ground-level in many "Blackwood" stands, ranging from 4 to 14 years of age, was determined by means of Clements's Stopwatch Photometer. Values as low as1/50, 1/100, 1/150, 1/200, 1/300, 1/400, 1/500, 1/700 of full Sunlight were registered. In no single instance did weed-growth of any kind exist under the trees nor did regeneration of native trees occur—apart from occasional, poorly-developed plants of *Royena lucida*, *Burchellia capensis*, *Plectronia Mundtii*, *Olea capensis*, *Celastrus acuminatus* and *C. buxifolius*. In several stands showing Light-intensities of 1/30, 1/40, and in one showing 1/100, some poorly-grown seedlings, several inches high, of *Podocarpus Thunbergii* Hook., *P. elongata* L'Herit., *Olea laurifolia*, *Apodytes dimidiata*, *Curtisia faginea* occurred, together with a few seedlings of the species previously listed.

From a series of Light-intensity experiments carried out at Deepwalls it was known that seedlings of *P. Thunbergii*, *P. elongata*, *O. laurifolia*, *A. dimidiata*, *C. faginea* could withstand for periods of 6-12 months such low Light-intensities as 1/1000–1/2000, that they existed but scarcely grew under values 1/500–1/1000, that they grew moderately well but were soft and delicate under values 1/200–1/500, and that they were vigorous and assertive under values 1/5–1/40. Accordingly cultures of plants of these species, of known age (usually 6-12 months from germination) and of known history (raised in nursery under known Light-intensity and known average moisture-content of the soil), were placed under several *A. melanoxylon* stands, the average Holard (total moisture-content of the soil) of the soil in the tins being regulated, and in every instance being kept at a value as near as possible to the known optimum for each species. The soil used was good, porous forest Clay-loam (15-20 per cent. Clay) of the type occurring on the sites where the "Blackwood" stands had been planted. The soil-surfaces were sealed so that the Holard might be regulated with care.

The responses shown by the cultures are summarized in *Table I*. These are of considerable interest and importance: they reveal the fact that in the instances of stands showing a Light-intensity lower than 1/200 at ground-level, development of the culture plants was not as good as that shown by plants of the same age, growing in the same soil, and receiving the same amount of water, but living under stands of *A. melanoxylon*, experiencing stronger Light-intensities at ground-level; furthermore, they show that while development of the culture plants under Light-intensities lower than 1/200 was not vigorous, the plants nevertheless, on account of receiving sufficiency of water, could live and could grow slowly. The information yielded by the cultures, combined with the knowledge that indigenous regeneration was sparse and very poorly developed under *A. melanoxylon* stands experiencing such congenial intensities as 1/10, 1/25, 1/40, at ground-level, seemed to suggest that the Light-intensity reaction was not the prime one, although evidently an important additional one.

Table I.

Responses of Holard-regulated Cultures grown under Acacia melanoxylon stands of Five different Intensities of Light.

Species.	Average Light-intensity (9 a.m.–4 p.m.) under which the Plants were raised.	Average Holard of the Nursery bed. (Dry-wt.).	Average Light-intensity at Ground-level, of the "Blackwood" stand under which the Cultures were Placed.	Average regulated Holard of the Culture Tins. (Dry-wt.).	Original Nature of the Plants.	Nature at End of 6 Months Life under the "Blackwood" stands.	Height-increment in 6 Months.
		%		%			Inches.
P. Thunbergii Hook...	1/10	40	1/25	40	Vigorous	Vigorous	2½–3
	1/10	40	1/100	40	Vigorous	Very fair	1–1½
	1/10	40	1/200	40	Vigorous	Fair, but tender	½–1
	1/10	40	1/400	40	Vigorous	All alive but show little vigour	½
	1/10	40	1/600	40	Vigorous	Vigour nil; but all alive	0
P. elongata L'Herit....	1/10	35	1/25	35	Vigorous	Vigorous	3–3½
	1/10	35	1/100	35	Vigorous	Very fair	2
	1/10	35	1/200	35	Vigorous	Fair	1
	1/10	35	1/400	35	Vigoruos	All alive, little vigour	½
	1/10	35	1/600	35	Vigorous	Vigour nil; all alive	0
O. laurifolia..........	1/10	40	1/25	40	Vigorous	Vigorous	2
	1/10	40	1/100	40	Vigouros	Fair	1
	1/10	40	1/200	40	Vigorous	Very fair	1
	1/10	40	1/400	40	Vigorous	Fair, but with less vigour than those under 1/2000	½
	1/10	40	1/600	40	Vigorous	Moribund	0
A. dimidiata..........	1/10	45	1/25	45	Vigorous	Vigorous	3
	1/10	45	1/100	45	Vigorous	Very fair	3
	1/10	45	1/200	45	Vigorous	Fair	1½
	1/10	45	1/400	45	Vigorous	Poor	1
	1/10	45	1/600	45	Vigorous	Poor, moribund	½
C. faginea...........	1/10	40	1/25	40	Vigorous	Vigorous	3½
	1/10	40	1/100	40	Vigorous	Very fair	3
	1/10	40	1/200	40	Vigorous	Fair	1
	1/10	40	1/400	40	Vigorous	Poor; vigour nil	0
	1/10	40	1/600	40	Vigorous	Moribund	0

II. The Reaction of *Acacia melanoxylon* R.Br. on the Holard.

1. *Determination of the Holard in* Acacia melanoxylon *stands.*

With the object of determining the average Holard at definite depths under stands of the species, a series of soil cores were taken by means of a soil-borer, bi- or tri-weekly, for the space of 12 months at depths of 6, 12, 18 and 24 inches at certain stations, and at depths of 6 and 12 inches only at others. The cores were placed at once in air-tight containers, weighed, oven-dried until constant weight (usually after 12 to 18 hours at 105 deg. Fahr.), desiccated over Calcium chloride for a further 12 hours, then rapidly re-weighed.

A summary of Holard values, together with notes concerning the stands, the Light-intensity at ground-level, and the occurrences of regeneration of native species, is given in Table II.

The data shown in Table II definitely show that the soil under "Blackwood" stands is considerably drier than that obtained from sites within the same locality but free of the aforementioned species; the Holard, indeed, is reduced to values closely approaching the Wilting coefficient or the Echard (non-available moisture-content of the soil) for the particular soils and the particular species.

The greatest reduction appears to be at depths of 18 and 24 inches—bisects show that the greatest development of the rootlets of "Blackwood" occurs between 15 and 24 inches, hence the drier nature of the soil between these limits. The control Holard values given in Table II show the soil at 18 and 24 inches to be drier than that at 6 and 12 inches; here, again, the reason is that the greatest development of feeding rootlets of the trees (native species) occurs at the 18 to 24 inches level.

Quadrats of 1 square-meter area, set out under the stands 1, 2, and 5 described in Table II, revealed the information (*a*) that the increment of the naturally-established native seedlings was either nil or exceedingly small; (*b*) that many first stage seedlings of *P. Thunbergii*, *O. laurifolia*, *Apodytes dimidiata*, *Curtisia faginea*, and *Royena lucida* died before they could establish themselves—unless the weather happened to be particularly wet at the time of germination of the seed; (*c*) that a number of the seedlings of several inches in height wilted and died during dry spells—that is, if rain did not fall for the space of 7 to 21 days, or if Foehn ("Berg," or warm, dry winds) winds were prevalent.

Table. II.

AVERAGE HOLARD VALUES AT VARIOUS DEPTHS UNDER A. MELANOXYLON STANDS, TOGETHER WITH HOLARD VALUES FOR CONTROL SITES.

Stand. (:x:1)	Light-intensity and Aspect.	Natural Regeneration of Native Tree Species.	Depth of Core.	Nature of the Soil.	Average Holard. (Dry-wt.).	Nature of Control Site.	Average Holard. (Dry-wt.).
			Inches.		%		%
1	1/40. Flat....	Few P. Thunbergii, Apodytes, Curtisia; O. laurifolia and Royena lucida frequent. All poor and non-assertive	6	Humus and sandy loam	19	Light: 1/50, fairly open high forest, with P. Thunbergii, O. laurifolia, Apodytes, Curtisia frequent	40
			12		17		35
			18	Clay loam	17		32
			24	Clay loam	17		30
2	1/50. Flat.....	Few P. Thunbergii, Curtisia, O. laurifolia, Burchellia capensis, Plectronia Mundtii, and Celastrus buxifolius. All poor; some dying at each dry spell	6	Humus and sandy loam	16	Light: 1/100; closer high forest with above spp. and a second layer of smaller trees	43
			12		16		36
			18	Clay loam	14		30
			24	Clay loam (15% clay)	13		28
3	1/40. North...	No regeneration; a few Blechnum punctulatum and Aspidium capense	6	Humus and sandy loam	14	Light: 1/200:; close high forest rich in P. Thunbergii and O. laurifolia, with layer of Trichocladus crinitus	35
			12		12		33
			18	Sandy loam	11		26
			24	Sandy loam (8% clay)	10		26
4	1/25. North...	No regeneration; a few Aspidum capense	6	Humus and sandy loam	12	Light: 1/75; open high forest, with P. elongata, Ocotea bullata, and P. Thunbergii	30
			12		10		27
			18	Sandy loam	—		—
			24	Sandy loam (10% clay)	—		—
5	1/100. South..	A few P. Thunbergii, P. elongata, Apodytes, and Olea laurifolia. All poor	6	Humus and clay loam	17	Light: 1/150, high forest rich in P. Thunbergii, O. laurifolia, and with some Trichocladus crinitus	41
			12		15		35
			18	Clay loam	—		—
			24	Clay loam (18% clay)	—		—

2. *Holard Experiments.*

(i) On 4-meter-square quadrats set out under stands 1, 2 and 5 described in Table 2, carefully-selected, viable seeds of *Curtisia faginea, Olea laurifolia, Podocarpus Thunbergii* were sown; 300 of each species to a quadrat, 3 quadrats to a stand. The seeds were protected from birds and mammals by means of fine wire-mesh. The degree of germination was recorded for each species on each of the 9 quadrats. A summary of the *germination percentages* and *establishment percentages* is given in Table 3; it is seen that while the *percentage of germination was high* (compare percentages shown by the same stock of seed, sown at the same time, on 9 control quadrats under normal forest conditions, but not far removed from stands 1, 2, and 5—Table 4) *the percentage of establishment* was extremely low, despite the very fair conditions of light the quadrats received.

Table III.

SEMINARIA UNDER A. MELANOXYLON STANDS: % GERMINATION AND ESTABLISHMENT.

Stand.	Average Holard. (6 Inch).	Average Light-intensity.	C. faginea.		O. laurifolia.		P. Thunbergii.	
			Per cent. Germination. (: x : 1)	Per cent. Establishment.	Per cent. Germination.	Per cent. Establishment.	Per cent. Germination.	Per cent. Establishment.
1	% 19	1/40	% 57	% 5	% 81	% 7	% 65	% 2
2	16	1/50	62	4	78	5	51	3
5	18	1/100	69	4	85	10	70	2

Table IV.

SEMINARIA UNDER NORMAL FOREST CONDITIONS: CONTROL ON ABOVE.

Forest.	Average Holard. (6 Inch).	Average Light-intensity.	C. faginea.		O. laurifolia.		P. Thunbergii.	
			Per cent. Germination.	Per cent. Establishment. (: x : 1)	Per cent. Germination.	Per cent. Establishment.	Per cent. Germination.	Per cent. Establishment.
1	% 40	1/50	% 59	% 83	% 75	% 90	% 68	% 90
2	40	1/100	60	90	82	93	64	90
3	42	1/30	63	91	75	88	66	88

Notes to Tables 3 *and* 4.

(: x : 1). Percentage of establishment is calculated on the number of plants that actually were yielded by the seed, and on the proportion of these that survived at the end of 4 months.

The overwhelming majority of the deaths on quadrats under " Blackwood " stands was due to wilting of the plants on account of insufficient water.

(ii) Blocks of soil 9 inches deep by 18 inches in length—taken from " Blackwood " stands and containing a few naturally-established seedlings each of *P. Thunbergii*, *P. elongata*, *O. laurifolia*, *Apodytes*, *Curtisia*, and *Royena lucida*—were placed in tins, the soil-surfaces of the tins were sealed with a mixture or parawax-petrolatum; the sealed cultures were kept under a Light of 1/50, and were never watered, the object being to cause wilting of the seedlings very gradually. The history of the experiment is summarized in Table 5.

Table V.

WILTING OF NATURALLY ESTABLISHED SEEDLINGS IN SEALED SOIL BLOCKS REMOVED FROM A. MELANOXYLON STANDS.

Block No.	Original Holard of the Block, at 3 Inches. (Dry-wt.).	Species of Seedlings.	Wilted at. (Dry-wt.).	Time Required.	Soil Nature.
	% 18	P. elongata........ P. Thunbergii...... O. laurifolia........ Apodytes.......... Curtisia............ Royena............	% 10 11 12 14 12 12	8 to 12 days	Clay loam, 15 per cent. clay, humus 10 per cent.
2	16	P. elongata........ P. Thunbergii...... O. laurifolia........ Apodytes.......... Curtisia............ Royena............	10 12 12 13 12 12	5 to 7 days	Sandy loam 7 per cent. clay, humus 8 per cent.
3	22	P. elongata........ P. Thunbergii...... O. laurifolia........ Apodytes.......... Curtisia............ Royena............	11 11 12 13 13 13	14 to 21 days	Clay loam, 18 per cent. clay, humus 10 per cent.

Note to Table 5.

The cultures were kept in well-aerated, cool sites.

The experiment indicates that were no rain to fall for a period of 14-21 days the seedlings of Block 3 would succumb to drought, that were the rain to be withheld for 8-12 days from Block 1, death would follow, and that the plants of Block 2 could not survive unless rain fell within 5 to 7 days. The fact that the Holard of the Blocks so nearly approached the Echard for the soil and for the seedlings used is well shown up, especially in the instance of the second Block, where the Holard is but 3-6 per cent. above the Echard.

(iii) Two 4-square-meter quadrats per stand were set out under " Blackwood " stands 2 and 5 (*vide* Table 2 for details); these quadrats each showed a few seedlings of the following species: *P. elongata*, *P. Thunbergii*, *O. laurifolia*, *Apodytes*, *Curtisia*, and *Royena lucida*. These quadrats were watered so that their average Holards were appreciably increased, as shown in Table 6, page 12; 4 control quadrates containing seedlings of the same species were left unwatered, the object being to compare the nature of the seedlings on Holard-increased quadrats with that of seedlings on quadrats of low Holard. Table 6 is a summary of the responses shown by the various species—the influence of watering was evident at first sight: general improvement of the condition of the plants, and practically an entire absence of mortality. Unwatered plants, however, fared badly, especially as several drought and Foehn-wind periods occurred during the course of the experiment.

From the determination of Holard at several depths in various stands of *A. melanoxylon*, germination-establishment experiments, the un-watered soil block experiments, and the increased Holard experiment, it is manifest that *A. melanoxylon reduces the soil-moisture to a degree unfavourable to the normal development of the seedlings of P. Thunbergii, P. elongata, Apodytes, Olea laurifolia, and Curtisia, and that it occasionally brings about the death of seedlings of these species by reducing the Holard to points either equivalent to, or below, the Echard.* It is known that seedlings of *Ocotea bullata, Platylophus trifoliatus, Cunonia capensis*, and *Ekebergia capensis* are just as sensitive to a greatly reduced water-content as the species listed in the foregoing Holard experiments, and there can be little doubt that *A. melanoxylon* would have the same detrimental influence on them.

Referring, then, to the two hypotheses concerning the poverty of regeneration of indigenous species under " Blackwood " stands, it is seen that both were actually true, but that the major rôle is played by the water-reducing reaction of the species, and the minor by that of Light-intensity reduction. Combined, the two reactions are exceeding potent.

The Rate of Loss of Water from Foliage under Normal Conditions of Temperature and Humidity of the Air.

In passing, a few remarks concerning the rate of loss of water from foliage of *Acacia melanoxylon* will assist in explaining why the species makes such strong demands upon the soil-moisture:—

(i) The *actual loss per unit area* of the simple, leaf-like *phyllodes*, or petioles so flattened as to set their surfaces vertically, is *not extremely high*, but is higher than the loss from equal areas of the surfaces of leaves of most of the indigenous forest trees, except *Virgilia, Ocotea, Curtisia.* On the other hand, the *total transpiring surface* of the average *A. melanoxylon* is considerably greater than that of many of the species indigenous to the forests—the *phyllodes* are exceedingly numerous and *in toto* form a well-knit transpiring surface.

The following is a typical example of the transpiring capacity of the species:—

Transpiration per square-metre of phyllode-surface per ***hour***: 19.17 c.c.

Hours: 11 a.m.–4 p.m. 14th August, 1925.

Temperature during this period (*shade*):—

11 a.m.	58.0	deg. Fahr.
12 noon.	59.0	,,
1 p.m.	58.5	,,
2 p.m.	58.5	,,
3 p.m.	55.0	,,
4 p.m.	54.0	,,

Temperature Maximum in Sun during this period.
101.25 deg. Fahr.

Light-intensity (in transpiration screen).
0.5 of full day-light.

Sunshine.
Sky unclouded, full sunshine throughout period.

Relative Humidity during the period.

11 a.m.	68 per cent.
12 noon.	67 ,,
1 p.m.	67 ,,
2 p.m.	68 ,,
3 p.m.	70 ,,
4 p.m.	74 ,,

Wind.
Forces 0 to 1, Beaufort Scale.

During the same period, Ocotea and Curtisia transpired 20.8 c.c. and 25.0 c.c. per square-metre respectively.

(ii) Experiments on the rate of water-loss during the drying of leaves detached from the parent tree were carried out, employing the methods described by Bews (1923: 44-56), and showed the following points of interest:—

Phyllodes of *A. melanoxylon* suddenly removed from a fully saturated atmosphere (bell-jar over water, with branchlets standing in the water for 12 hours) and placed in an incubator at a constant temperature of 25 deg. C. (77 deg. Fahr.) and relative humidity 70 per cent., at the end of 24 hours showed a *considerably smaller water-balance* than either Ocotea or Curtisia leaves submitted to the same treatment. Thus:—

A. melanoxylon	showed a balance	of	21.01 per cent.
Ocotea	,,	,,	26.79 ,,
Curtisia	,,	,,	59.30 ,,

Bews (*loc cit.*, p. 50), employing a temperature of 25 deg C., found that in the same time (24 hours) water-balances were shown by the species studied as follows:—

Greyia Sutherlandi	16 per cent.
Protea Roupelliae...	20 ,,
Podocarpus elongata L'H.... ...	38 ,,
Crassula sp.	66 ,,

It seems then that *A. melanoxylon* is *less resistant* to water-loss than Ocotea, *Podocarpus elongata* L'Herit., Curtisia, and *Crassula* sp., and more resistant than Greyia and *Protea Roupelliae* on being suddenly exposed to desiccating conditions. It is known that Holard decrease is greatest in times of high temperature and low relative humidity, and this possibly is due to the greater demands made by the Acacia upon the moisture in the soil, at such times.

Table VI.

SUMMARY OF RESPONSE OF SEEDLINGS UNDER ACACIA MELANOXYLON STANDS TO INCREASED HOLARD TOGETHER WITH RESPONSE OF SEEDLINGS ON UNWATERED CONTROL QUADRATE.

Stand.	Original Holard on Quadrat at 6 Inches.	Holard (6 Inches) Raised to Average of	RESPONSES MADE BY THE VARIOUS SPECIES OF SEEDLINGS IN THE COURSE OF THREE MONTHS.											
			P. elongata.		P. Thunbergii.		O. laurifolia.		Apodytes.		Curtisia.		Royena.	
			Watered.	Control.	Watered.	Control.	Watered.	Control.	Watered.	Control.	Watered.	Control.	Watered.	Control.
2	Quadrat 1 16%	% 30	Very fair, no deaths	Very poor, mostly dead	Very fair, no deaths	Very poor, mostly dead	Very fair, no deaths	Very poor, mostly dead	Very fair few deaths	Very poor, some dead	Very fair , no deaths	Very poor, all dead	Very fair, no deaths	Very poor, some dead
2	Quadrat 2 15%	32	,,	,,	,,	Very poor, all dead	,,	Very poor, all dead	Very fair, no deaths	Very poor, all dead	Very fair, few deaths	,,	,,	,,
5	Quadrat 1	30	,,	,,	,,	,,	,,	,,	,,	,,	Very fair, no deaths	,,	,,	,,
5	Quadrat 2 18%	33	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

The Possibility of Undesirable Spread.

Assuming then that *Acacia melanoxylon* is definitely detrimental to the regeneration of the indigenous trees of the Knysna, on account of its reactions on Light and on Holard, the question whether there is danger of the species spreading in the natural forests to an undesirable extent immediately arises. The following points throw much light upon the matter.

1. *A. melanoxylon* produces seeds in the greatest profusion: some trees are never found without seed, some seed several times per year, others bear rich crops annually. It is estimated, on the basis of counts of seeds produced by certain branches of certain trees, that the average " Blackwood " of 10-14 years of age produces about 250,000 seeds per annum.

2. The seeds are 90-99 per cent. viable.

3. The seeds are dispersed by Elephant, Bushbuck, Grijsbok, Bluebuck, Wild Pig, Field Mice, Moles, and Cattle. Elephant, the bucks, Wild Pig, and Cattle browse on the foliage of the " Blackwood," accidentally swallow the seeds, and pass these through their systems; when deposited with the faeces the seeds are much softened and germinate within 7-21 days.

Occasionally Bushdoves, *Amydrus morio* (" Red-winged Starling "), and domestic fowl carry the seed over short distances, but the passing of the seed through the systems of these birds does not assist germination.

On rare occasions Ants may be seen bearing freshly-fallen seeds over short distances for the sake of the oily matter at the hilum.

The seeds are carried long distances by water—heavy rains, streams, and rivers. The planting of small patch of " Blackwood " near the banks of the " Rondebos " stream, Deepwalls, in 1915, has been responsible for the dispersal of seed and the consequent establishment of seedlings, poles, and small trees of the species along the whole length of the " Rondebos " and allied streams——a distance of not less than 20 miles of stream-bank. In the same manner, " Blackwood " planted at Jubilee Creek, Millwood, about 1913, has supplied seed for dispersal by the Forest Creek stream and the " Homtini " River—dense patches of regeneration of all sizes are to be found along the banks of these water-courses.

4. The small, hard seeds of the species are decidedly long-lived. Cambage (1924) has shown that the seed germinates freely after $7\frac{1}{2}$ years' immersion in sea-water.

The following experiments at Deepwalls indicate that the seeds are capable of lying dormant until such time as they stimulated to germinate, through rupture of the testae by trampling, or softening of the testae through agency of fire:—

(*a*) An area situate 10-15 yards north of a stand of " Blackwood " planted in 1912, until 1924 bore a dense 15-20 feet high thicket of *Halleria lucida, Rhamnus prinoides, Polygala myrtifolia* with a luxuriant undergrowth of *Blechnum capense*. From a 100 square yards of the area all the vegetation was very carefully removed: thousands of seeds of *A. melanoxylon* were lying either on or immediately below the soil surface, but not a single seedling occurred.

The 100 square yards were then trampled by several labourers for the space of 5 minutes, the seeds being trampled with the soil.

Within several weeks a dense regeneration of *A. melanoxylon* appeared on the trampled site.

From a second 100 square yards the vegetation was very carefully removed, but no trampling was done. Seeds of *A. melanoxylon* lay upon the soil in thousands: apart from small portions unavoidably disturbed in the clearing process, the area showed no regeneration at the end of several months.

From a third 100 square yards the vegetation was very carefully removed, and portions of the soil were fired by means of igniting spread-out brushwood: the fired soil at the end of several weeks bore a most luxuriant and dense crop of *A. melanoxylon* seedlings.

5. Regeneration of *A. melanoxylon* is *decidedly Light-demanding* and does not develop normally unless the Light-intensity is above 1/6 of full sunlight. A large number of naturally-established seedlings growing under Light-intensities of 1/12, 1/15, 1/20 have been kept under observation since April, 1924, and it has been found that these plants, although 3 to 4 years of age, still retain their *juvenile foliage* and are attenuated, whippy, etiolated, and tend to fall under the weight of their own foliar shoots.

6. Regeneration receiving sufficient light and growing in forest soil develops rapidly: plants 20 feet in height (full) by 6 to 9 inches in girth, are produced in 2 to 3 years.

7. The species sends up an abundance of "*root-suckers*" whenever the roots are in any way disturbed; such "*suckers*" may occur 30 to 60 feet away from the parent bole, and are capable of growing into normally-shaped, large trees, which in turn produce seed and "*suckers.*"

8. The root-system of *A. melanoxylon* is extensively developed, radiating 70 to 100 feet from the boles in instances of large trees.

In view of the facts: (1) that "Blackwood" produces an abundance of seed of 90-99 per cent. viability, and "*suckers*" freely; (2) that the seed is dispersed to some extent by mammals and birds, and to a greater extent by water; (3) that the seed is capable of lying dormant for lengthy periods; (4) that the regeneration is very fast growing, under congenial conditions, it would seem that there is strong possibility of the species spreading considerably in time.

On the other hand the facts: (1) that the seed requires stimulating ere it will germinate; (2) that the regeneration cannot develop normally under any but strong light, argue that in normal, undisturbed forest where the degree of stimulation the seed would receive would be negligible and where the Light-intensities are usually of a low order, the degree of establishment would be insignificant. On exploitation of forest, with consequent trampling of the soil and opening up of the canopy, germination and establishment would occur wherever seeds of *A. melanoxylon* were lying in the soil. Disturbance of the ground in the vicinity of existing trees of the species would account for the appearance not only of regeneration but also of large numbers of "*suckers.*"

The likelihood of the species spreading in the Macchia or "Fijnbos" would be slight indeed, for even when the latter is burned, slashed, grazed, or otherwise disturbed, the "Blackwood" does not thrive on the compact, acid soil, remaining stunted and unassertive.

On the whole, provided disturbance of forest in the soil of which seed of *A. melanoxylon* lies dormant, is not carried out to excess and on a large scale, there seems little danger of the species becoming uncontrollable. Willis (192) is correct in stating that native floras are not seriously influenced by exotic species unless agents of disturbance—principally the activities of man—assist the advances of the latter.

Proposals.

Acacia melanoxylon, it is seen, acts detrimentally upon the seedlings of the more important forest species of the Knysna, and is a plant that might become much commoner in the region if forest containing its dormant seeds were to be disturbed. A redeeming feature is the very efficient manner in which the species kills out light-demanding and rampant weed-growth, but it can be shown that the indigenous *Virgilia capensis* acts the same part in a manner scarcely less efficient.

It is suggested, therefore, that the planting of *A. melanoxylon* within the indigenous forests be discontinued.*

The practice of using the species as a living fire-belt is not considered sound, for the reasons that the natural processes of forest succession at the margins of the native forests are inhibited, and that the belt trees provide an abundance of seeds for dispersal in the forests adjacent to them.

It is therefore suggested that the forming of belts of *A. melanoxylon* along the margins if indigenous forests be discontinued.

From the economic point of view the planting of burnt or otherwise ruined native forest patches with *A. melanoxylon* appears sound, in that a yield of useful, saleable timber from the forests cannot be expected for several centuries at least, and in that the exotic species within half a century will produce utilisable material. On the other hand, the "Blackwoods" planted in such patches will form an important source of seed supply, and in this manner may act detrimentally upon adjacent forests of better quality.

It is suggested, therefore, that planting of burnt or ruined forest with *A. melanoxylon* should not be carried out if forest of better quality be adjacent.

Summary.

1. *Acacia melanoxylon* R.Br., the "Blackwood," was introduced to the indigenous forests on a sylvicultural scale in 1909, with the objects of killing weed-growth on exploited sites and assisting natural regeneration of indigenous species.

2. Observations showed that while the weeds were killed by the exotic, natural regeneration of tree species was either absent or poor under its stands.

3. Experiments showed that two reactions were responsible for this dearth of regeneration and for its poverty: reduced Light-intensity and reduced moisture-content of the soil, the latter being far the more important.

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* So far as the writer is aware (1930), this was discontinued in 1927.

4. The species, while seeding efficiently and abundantly, is not likely to spread in undisturbed natural forest on account of the seed requiring stimulation ere its germination is possible, and because its regeneration is markedly light-demanding. The seed can lie dormant for many years, and thus cause the spread of the species in years to come when forest now undisturbed, is worked.

5. It is suggested that planting of the species be discontinued within the forests as well as along the margins. The planting of burnt or ruined forest is considered advisable if no better quality forest is adjacent.

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Appendix III.

SUMMARY OF POINTS OF PRACTICAL SYLVI-CULTURAL NATURE, FORESTS OF THE KNYSNA.

SUMMARY OF POINTS OF PRACTICAL SYLVICULTURAL NATURE, INDIGENOUS FORESTS OF THE KNYSNA.

1. While the unexploited natural forests show, in most instances, dense stocking of large and small trees, poles, saplings, and undershrubs woody and herbaceous, resulting in *very greatly decreased intensity of light* at heights of 30 feet, 15 feet, and ground level, *high humidity of the air*, comparatively *low air temperature* and *low degree of evaporation*, regeneration of seedling, sapling, pole and small tree stages grows *at an exceedingly slow rate*. The various regeneration stages most surely will produce large timber trees in due time, but Nature's time is all too long for the forester. *The natural conditions must be improved where necessary, must be conserved where essential, cannot be depreciated with impunity.*

THE NATURAL CONDITION OF THE FORESTS, WHILE INDICATING GENERALLY THAT CONDITION WHICH THE FORESTER MUST ENDEAVOUR TO PRESERVE, MUST NOT, IN DETAIL, BE CONSIDERED AS THE IDEAL ONE FOR THE PRODUCTION OF TIMBER ON AN ECONOMIC BASIS: THE NATURAL CONDITION CAN BE IMPROVED APPRECIABLY, WITHOUT ITS FUNDAMENTAL NATURE BEING MUCH ALTERED.

2. There is a definite limit beyond which natural conditions must not be altered, if the future welfare of the forest be desired.

Experiments are showing that the natural forests are *over-dark* in most localities, that the introduction of *suitable degrees of illumination is favourable* to regeneration of all stages, in that increased increment per annum is put on, but that *introduction of excess light* —accompanied inseparably by greatly increased air temperature, insolation, evaporation, and greatly decreased humidity, *is productive of effects either merely retarding or definitely detrimental.* In like manner, competition for soil-moisture is often great during periods of local drought, young stage regeneration being either retarded or killed as the result, and while *removal of a certain proportion of the larger and smaller individuals on a unit area of ground produces beneficial results in the plants remaining, excess removal results in the appearance of dense communities of fast-growing, strongly competing weeds*, that not only filch soil-moisture from the young regeneration, but in addition, cut down the light supply of the latter.

In a word, our treatment of the forest must be such *that undue rupture of the canopy is not brought about.* Trees to be exploited must be so selected that their removal will not result in the production of large open areas or " focus spots." These " focus spots," according to locality, soil conditions, and aspect, rapidly are invaded by such weed spp. as Helichrysum petiolatum, H. parviflorum, Plectranthus fruticosus, Rubus spp., Cyperaceae, and various ferns, which either prevent germination of seeds, or kill or retard regeneration. In the course of succession these weed communities are ousted by such spp. as Cluytia pulchella, C. affinis, Halleria coppice, Burchellia coppice, Psoralea spp., Rhamnus prinoides, Nuxia coppice, etc.—but this process takes, it is estimated from observations on various " sectioned " (or exploited) areas, from 5-20 years according to locality. Thus it is 5-20 years before regeneration gets an opportunity of either appearing, or putting on any appreciable increment.

The " weed-stage " often can be avoided altogether by refraining from marking trees in groups; occasionally it is impossible to avoid the making of a " focus spot " (e.g. in the removal of large P. elongata L'Herit)—in such a contingency, rapid defeat of the " weeds " by the fast-growing *Virgilia capensis*, sown or planted as a " nurse," is advisable.

Occasionally the weed communities are either late in appearing, or may be somewhat open in structure. Regeneration (1-2 year) *in situ* is then lesioned by the excessive surface-soil temperature (140-166 deg. F.) when the exposure is a severe one, and either dies or is retarded.

3. Bearing in mind that the *canopy must be preserved wherever possible*, the following classes of *trees of saleable nature* require to be removed :—

Best Species.

Badly-shaped, damaged, diseased trees *above* the girth-limits at present in use* . . . . the so-called " *over-mature* " trees.

Such sound trees above the girth-limits as can be spared . . . . the so-called " *mature* " trees.

Such sound and unsound trees slightly below the girth-limits, as are over-crowded . . . . the so-called " *large immature* " trees.

Inferior Species.

Where the stocking is dense, removal of such saleable boles as will relieve the congestion, of such spp. as Plectronia spp., Royena lucida, Olea capensis, Celastrus acuminatus, C. peduncularis, Elaeodendron spp., is advisable. Better light conditions and decreased competition for soil moisture and solutes is thus brought about, provided the topmost layer is not too open.

It is a point of considerable importance that in addition to the removal of the *saleable trees*, removal of such unsaleable material as is efficient in cutting down the light-intensity and strongly competing with the regeneration of the better species, for supplies of moisture and food salts, should be carried out. Under the present system of " sectioning " *saleable material only is felled, dense stands of unsaleable spp.* doing no *good to the forest, being left undisturbed, together with small badly-shaped, or damaged boles of superior and inferior saleable species.* It often happens that saleable material is either scarce in or absent from a particular portion of a " section ": the conditions of stocking are too dense, the light too low to allow of good increment; the portion is passed over unassisted. It is just such a portion that requires sylvicultural treatment—suitable thinning and nettoiement.

4. Even after an area has been " sectioned " and suitably thinned, it often occurs that the conditions on the ground-level are still unsuitable for the establishment of new regeneration, or the satisfactory growth of established seedlings and small saplings: dense layer-societies of *Trichocladus cripitus* (" Underbush ") or of *Hemitelia capensis* (" Treefern ") being the agents bringing about the unfavourable conditions. In the instance of the former plant, the prime reactions are on the light-intensity, and on the moisture of the soil, a decrease in each of these factors being the outcome; in the latter instance (Hemitelia), decreased light-intensity, poor soil-seration, relatively high soil-acidity, and excessive moisture content of the soil are the unfavourable factors. Removal of, or heavy to

* In felling practice, Forest Department, Knysna.

medium thinnings of Trichocladus and Hemitelia are followed by increased numbers of seedlings and considerably improved height-increment in established seedlings and saplings. It naturally follows that removal of these plants, in degree, depends upon the existing conditions of the upper canopy—little or nothing should be removed from open sites, while entire communities should be removed where the upper canopy is dense.*

5. With the exception of localities rich in communities of *Trichocladus* and *Hemitelia*, the forests show from very fair to excellent regeneration in its various stages. Exploited forests rich in Trichocladus often show good regeneration above the Trichocladus even if that below this plant is poor. Transplanting of indigenous spp. of the better qualities, or sowing of seeds in exploited areas, usually, will not be found necessary, provided the " weeds " are not allowed to enter. Occasionally sowings or transplantings on sites not showing presence of seed-trees or of any established regeneration, would accelerate the production of seedling stages.

6. Coppice of Stinkwood, Wit Els, Assegaai, Hard Pear, when suitably thinned in their younger stages, produce excellent, fast-growing boles.

Stumps of these spp. should be suitably prepared after exploitation of the main boles; such gourmand-coppice as may already exist, should be thinned, so as to assist the development of the best shoots.

The best coppice is produced from shoots low on the parent-stump, and every care should be taken to assist the development of these, and to account for the removal of those placed high on the stump. Coppice should be re-thinned 2 to 3 years after the exploitation of the stumps producing the shoots.

7. When large *P. elongata L'Herit* and large *O. laurifolia*, are worked at the stump, a considerable depth and extent of chips is produced. These chip deposits may be from 6 inches to several feet in depth, and may cover from several to many square yards. Decay of the chips does not set in for several years; owing to the exudation of sap, and the rain-washings from the chips, strongly acid conditions are produced in the soil in the vicinity of the deposits. Regeneration of tree spp. is either entirely prevented from establishing itself on the deposits, or if initial establishment is successfully accomplished, the seedlings soon succumb on account of obtaining no root-hold. While weed-growth for some years is much retarded by the presence of the deposits, it ultimately flourishes on the decayed wood.

While it is realized that little good would be accomplished by removal of the smaller deposits, it is urged that steps should be taken to open up portions of the soil underlying the largest deposits, in order that regeneration might appear. In situ sowings in such cleared spots or the planting of sturdy seedlings of such spp. as P. elongata, Curtisia faginea, Faurea Macnaughtonii, or Olea laurifolia would accelerate the regeneration of such sites, on which insolation is not severe; severely insolated areas would require sowing or planting up with Virgilia cap.

† *December*, 1930: An inspection of some areas cleared of Trichocladus other woody shrubs in 1924-27 leads me to agree with Mr. Laughton that in moister sites full removal results in increased growth of such ferns as *Blechnum capense* and *B. punctulatum*. This likely is due to the increased moisture content of the soil, itself produced by removal of the water-filching Trichocladus.

8. While such factors as humidity, evaporation, soil acidity, and total available food salts in the soil, are known to play some part in the life-history of the forest environment, the leading rôles are played by light and soil-moisture. Experimental thinnings in the forests have shown that the girth-increment of large trees, poles, saplings is appreciably higher when suitable light-conditions are provided, than when the dark conditions of the unexploited forest occur. On the other hand, fully-exposed trees, poles and saplings may also put on good girth-increment.

The difference between the sites enjoying congenial light, suffering from poor light, or experiencing super-abundant light, is reflected more markedly in the height-increments of the trees, poles, saplings and seedlings on the several sites. Height-increment is best under the congenial conditions, is very little under the poor conditions, is only slightly greater under conditions of full-exposure. Indeed, on occasion, and according to species and conditions of the individuals, height-increment may be even less under full-exposure than it is under the darkest conditions.

Cultures of seedlings grown under controlled habitat-conditions, are showing that for the majority of the more important species, light-intensities varying from 1/50 to 1/10 (full-exposure being taken as 1), are the most congenial.

Under forest-conditions, degrees of light approximating the values above given, with a little experience, can readily be obtained.

9. So far as my experience goes, exotic plantings in the indigenous forest appear to have little useful function. "Blackwood,"* when not eaten by elephant and buck, grow rapidly, consuming large quantities of soil moisture and solutes, and react unfavourably upon the indigenous regeneration. Eucalypts have been little planted, but appear to react in much the same manner as the Blackwood. The occasional plantings of Pinus insignis in burned forest are not yet old enough to enable me to draw any useful conclusion concerning their merits or demerits.

For a better "nurse" crop than the indigenous Virgilia capensis we need not look. Halleria lucida is also useful, but is much slower in its rate of growth.

10. With the exception of Ocotea bullata, the more important indigenous species are readily raised from seed if the latter be sown in the correct manner. Transplanting of the seedlings presents little difficulty if suitable localities are selected and the weather at the time be sufficiently cool and moist; all plantings on severely exploited sites should be done under protection of a "nurse" crop.

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* Acacia melanoxylon R. Br., *vide* Appendix II.

Appendix IV.

"A BRIEF SUMMARY OF FLORISTIC DATA FOR THE DISTRICTS OF GEORGE, KNYSNA, HUMANSDORP, AND UNIONDALE."

Appendix IV.

A BRIEF SUMMARY OF FLORISTIC DATA FOR THE DISTRICTS OF GEORGE, KNYSNA, HUMANSDORP, AND UNIONDALE.

On account of the lack of published data concerning the prime floristic features of the country included in the Districts of George, Knysna, Humansdorp, and Uniondale, the following brief summary is of interest.

The data submitted have been compiled principally from the following sources:—

(1) Records published in the "Flora Capensis."
(2) Records given in S. Schönland's manuscript preliminary list of plants occurring in the Districts of George, Knysna, Humansdorp, and Uniondale. (Vols. 1, 2, and 3 of the "Flora Capensis" only.)
(3) Records given by H. G. Fourcade in his manuscript list of plants occurring in the same region.*
(4) Records of plants collected by John Phillips, within the region above-mentioned.

It is desired to thank Professor Schönland for the gift of a copy of his preliminary list and for his kind assistance with the identification of numerous specimens, Dr. H. G. Fourcade for the privilege of studying his manuscript list, and the staff of the Bolus Herbarium for assistance with the identification of a number of plants.

For the larger families, e.g. Compositae, Leguminosae, Orchidaceae, Ericaceae, Gramineae, Cyperaceae, Iridaceae, Liliaceae, Geraniaceae, the numbers of species given are approximate only, there being numerous plants belonging to these families that have not been collected as yet, while a certain number of unidentified specimens are not included.

Phanerogams alone are dealt with in the summary, the data concerning the Cryptogams being too meagre as yet to warrant summarization.

Systematic Elements of the Flora.

The Districts under description lie within the *South-Western Region* of Bolus (1886; 1905), but in reality their vegetation in many respects is different from that of typical *South-Western* nature. The Macchia, on the whole, is more luxuriant, the Subtropical element is more pronounced, and toward the North Semi-karroid and even Karroid conditions obtain. Despite the contentions of Schönland (1919) that the Langkloof (within the Districts of George, Uniondale, and Humansdorp) has "*an almost pure South-Western flora*," and that karroid and eastern types extend to the Cape Peninsula while certain south-western types occur together with karroid and eastern types as far as Grahamstown, the writer is inclined to agree with Rehmann (1880) and Engler (1910) in looking upon the territory between Mossel Bay on the west and Van Staden's on the east, as a region transitional between the *South-Western* and the *South-Eastern* floras.

* By far the fullest list compiled, and containing much valuable information.

The area under description extends about 160 miles from west to east with an average width of about 35 miles, its area being roughly 6,000 square miles.

For sake of interest the *South-Western* region of Bolus is referred to also—its area being roughly 35,000 square miles. Schönland (1919) has supplied interesting data for the Districts of Uitenhage and Port Elizabeth (including portion of the adjacent District of Alexandria), to the east of the area under description, therefore these Districts too are considered; their approximate area is about 4,000 square miles.

The total† numbers of Families, Genera, and Species for the Districts of George, Knysna, Humansdorp, and Uniondale are as follows:—

	Families.	Genera.	Species.*
Gymnosperms	3	3	4
Monocotyledons	17	153	512
Dicotyledons	99	457	1,669
Totals	199	613	2,185

* Native species only.

Schönland (1919:17) gives the following summary for the Districts of Uitenhage and Port Elizabeth:—

	Families.	Genera.	Species.
Gymnosperms	3	3	7
Monocotyledons	22	203	637
Dicotyledons	104	510	1,668
Totals	129	716	2,312

Despite minor alterations due to subsequent collections, the data submitted by Bolus (1905:215) for his whole *South-Western* Region, are of interest:—

	Families.	Genera.	Species.
Gymnosperms	1	2	5
Monocotyledons	17	155	1,301
Dicotyledons	92	548	4,279
Totals	110	705	5,585

The proportion of genera to species is as follows:—

†Area under discussion 1:3.5
Districts of Uitenhage and Port Elizabeth 1:3.2
South-Western Region of Bolus (1905) 1:7.9

The proportions of Monocotyledons to Dicotyledons is:—

†Area under discussion 1:3.2
Districts of Uitenhage and Port Elizabeth 1:2.6
South-Western Region of Bolus (1905) 1:3.9

† Approximate.

The families, according to the numbers of species they contain, may be listed as follows:—

Family.	Species.	Genera.	Percentage of the whole.
Compositae	294	72	13·4
Leguminosae	148	34	6·7
Orchidaceae	118	28	5·4
Ericaceae	108	12	4·9
Gramineae	87	39	3·9
Cyperaceae	86	20	3·9
Iridaceae	83	20	3·8
Scrophulariaceae	69	20	3·1
Liliaceae	69	20	3·1
Aizoaceae	61	6	2·8
Proteaceae	51	10	2·3
Crassulaceae	47	4	2·2
Geraniaceae	45	3	2·0
Euphorbiaceae	45	12	2·0
Thymeleaceae	43	5	1·9
Rutaceae	43	12	1·9
Restiaceae	41	9	1·9
Campanulaceae	39	9	1·8
Asclepiadaceae	34	15	1·5
Santalaceae	32	5	1·4
Polygalaceae	30	3	1·3
Umbelliferae	30	16	1·3
Amaryllidaceae	26	11	1·2
Rhamnaceae	25	4	1·1
Labiatae	25	7	1·1
Gentianaceae	24	5	1·1
Selaginaceae	22	3	1·0
Celastraceae	21	7	0·9
Cruciferae	21	6	0·9
Roseacea	20	6	0·9
Rubiaceae	20	12	0·9
Sterculiaceae	20	1	0·9
Smaller families, as below	—	—	17·5
			100·0
Solanaceae	19	5	—
Malvaceae	18	5	—
Oxalidaceae	18	1	—
Anacardiaceae	17	2	—
Acanthaceae	16	10	—
Boraginaceae	15	4	—
Caryophyllaceae	14	5	—
Convolulaceae	13	5	—
Ebenaceae	12	2	—
Polygonaceae	9	3	—
Ranunculaceae	9	4	—
Bruniaceae	9	5	—
Juncaceae	8	2	—
Oleaceae	8	2	—
Sapindaceae	7	6	—
Myricaceae	6	1	—
Cucurbitaceae	6	3	—
Chenopodiaceae	6	4	—
Flacourtiaceae	6	4	—
Apocynaceae	5	4	—
Vitaceae	5	1	—
Zygophyllaceae	5	2	—
Capparidaceae	5	3	—
Loganiaceae	5	4	—
Penaeaceae	5	1	—
Amarantantacea	4	4	—
Loranthaceae	4	2	—
Linaceae	4	1	—
Haemadoraceae	4	3	—
Verbenaceae	4	3	—
Urticaceae	4	2	—
Myrsinaceae	3	1	—
Menispermaceae	3	2	—
Icacinaceae	3	3	—
Halorrhaginaceae	3	3	—
Droseraceae	3	1	—
Bignoniaceae	3	2	—
Araliaceae	3	1	—
Dioscoraceae	3	2	—
Commelinaceae	3	2	—
Potamogetonaceae	3	2	—

Family.	Species.	Genera.	Percentage of the whole.
Portulaceae	3	2	—
Plumbaginaceae	3	2	—
Piperaceae	3	2	—
Plantaginaceae	2	1	—
Tiliaceae	2	2	—
Primulaceae	2	1	—
Taxaceae	2	1	—
Aponogetonaceae	2	1	—
Balsaminaceae	2	1	—
Cunoniaceae	2	2	—
Dipsaceae	2	2	—
Guttiferae	2	1	—
Hamamelideacae	2	1	—
Lauraceae	2	2	—
Lentibulariaceae	2	1	—
Ochnaceae	2	1	—
Papaveraceae	2	2	—
Phytolaccaceae	2	2	—
Moraceae	2	1	—
Pittosporaceae	1	—	—
Passifloraceae	1	—	—
Salicaceae	1	—	—
Salvadoraceae	1	—	—
Sapotaceae	1	—	—
Saxifragaceae	1	—	—
Scheuchzeriaceae	1	—	—
Typhaceae	1	—	—
Ulmaceae	1	—	—
Valerianaceae	1	—	—
Aroidaceae	1	—	—
Callitrichaceae	1	—	—
Cornaceae	1	—	—
Elatinaceae	1	—	—
Frankeniaceae	1	—	—
Gesneraceae	1	—	—
Goodeniaceae	1	—	—
Meliaceae	1	—	—
Melianthaceae	1	—	—
Nympheaceae	1	—	—
Oliniaceae	1	—	—
Musaceae	1	—	—
Lemnaceae	1	—	—
Rafflesiaceae	1	—	—
Cycadaceae	1	—	—
Pinaceae	1	—	—
Resedaceae	1	—	—

Genera represented by more than 15 species (numbers in brackets) are as follows:—

Erica	about	93
Senecio	,,	50
Mesembryanthemum	,,	50
Pelargonium	,,	41
Helichrysum	,,	39
Crassula	,,	36
Aspalathus	,,	31
Indigofera	,,	30
Sutera	,,	30
Thesium	,,	25
Agathosma	,,	25
Satyrium	,,	25
Ficinia	,,	24
Phylica	,,	22
Disa	,,	21
Hermannia	,,	20
Eurphobia	,,	19
Oxalis	,,	18
Selago	,,	17
Psoralea	,,	16
Muraltia	,,	15
Leucadendron	,,	16

It is interesting to note that the genera with more than 15 species, in the Districts of Uitenhage and Port Elizabeth, are found among those listed above—with the sole exception of *Aloe*: Ficinia (23), Mesembryanthemum (64), Crassula (49), Aspalathus (20), Indigofera (22), Pelargonium (35), Oxalis (19), Agathosma (16), Euphorbia (22), Rhus (21), Hermannia (22), Erica (30), Sutera (16), Helichrysum (40), and Senecio (59)—Schönland (1919 : 18).

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* See also Fantham and Robertson in Addendum.

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"FOREST-SUCCESSION AND ECOLOGY IN THE KNYSNA REGION."

Maps* showing Forest Types and General Geological Features.

Knysna West -	XXVIII.
Knysna Central	XXIX.
Knysna East	XXX.

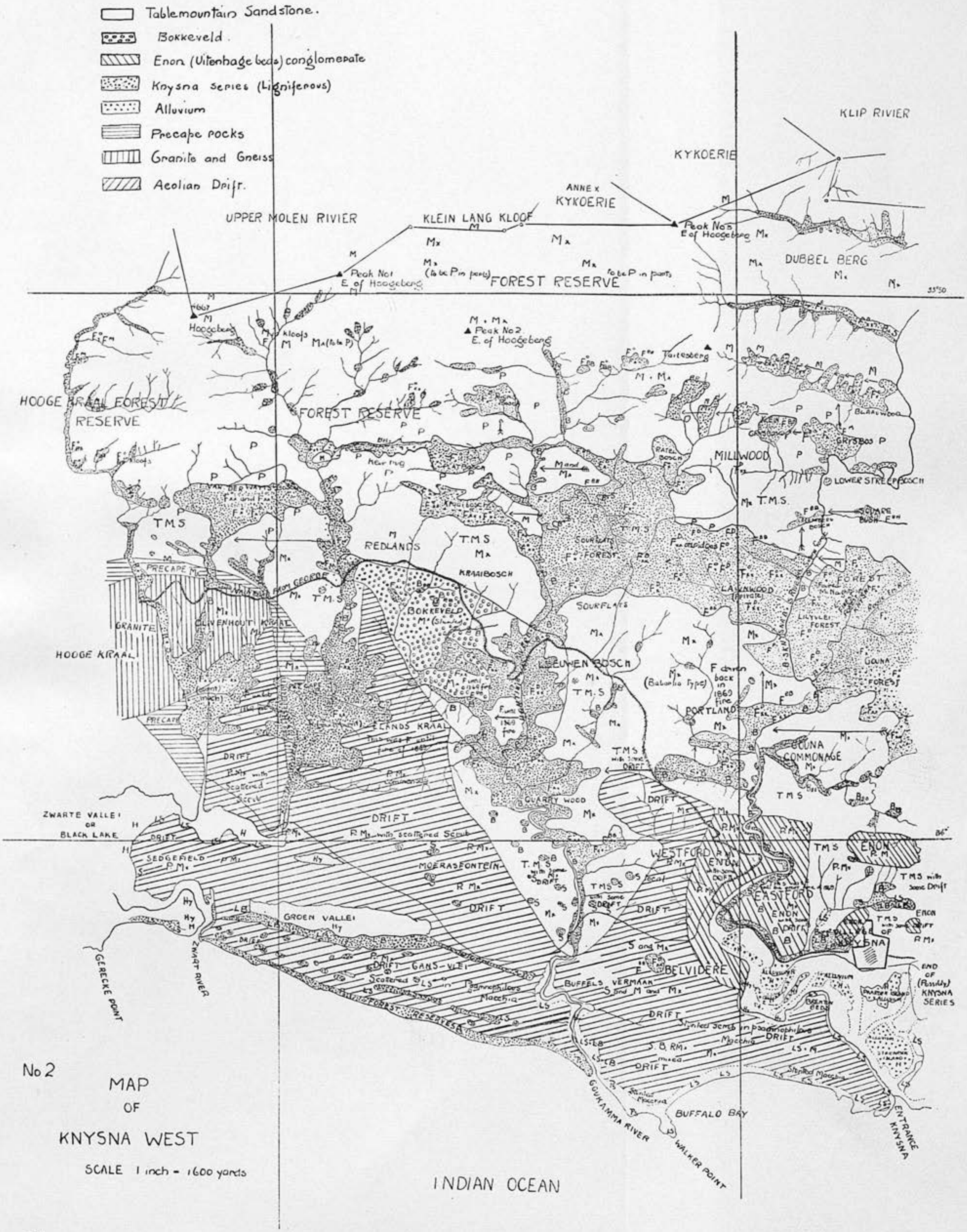
* Maps of portion of the George District, anad of the region East of the Blaauwkrantz River to the Eerste River have not been reproduced; these may be seen on application to the author.

Explanation of Symbols: Vegetation Maps.
Knysna Region

Topographical features traced from divisional maps compiled from plans filed in the Surveyor General's office. Vegetation details by John Phillips. Geological features largely based upon Schwarz's work of 1905 ______

Maps	Symbol	Explanation of the Symbol, and Remarks
(1) (2) (3) (4) + (5)	B.	Bush.
	Fv	Forest in relatively natural condition.
	Fx	Forest exploited.
	Fxx	Forest severely exploited. This type of forest is largely privately owned.
	F^{B}	Forest burnt and slowly recovering.
	F^{BB}	Forest burnt periodically and gradually decreasing in area. Fires originating in the Macchia either by accident or design, year after year, attack the margins of isolated forest patches.
	F^{D}	Forest of dry nature: i.e. occurring on drier soil. In the Zitzikanma Region most of the dry forests are on Bokkeveld. Average Holard: 25%–30% (dry weight)
	F^{M}	Forest of Moist Nature: i.e occurring on moist soil. These Forests are found principally along valleys, in depressions, and on the cool Southern slopes of the higher foot-hills of the mountains. Average Holard 100% to 170% (dry weight.
	F°	Forest of Medium-moist Nature: these forests are intermediate to the F^{D} and F^{M} types. Average Holard 45%-60% (dry weight)
	H.	Initial stages of the Halosere extensive
	Hy	Initial stages of the Hydrosere extensive
	L. B.	Littoral Bush.
	L. S.	Littoral Scrub.
	M.	Macchia: disturbed to some extent, but usually tall and well advanced
	Mx	Macchia: disturbed constantly by fire, grazing, agriculture; seldom allowed to grow tall.
	P.	Plantations of exotic trees principally spp of Pine and Eucalyptus.
	P. Mx	Macchia of psammophilous type.

Maps	Symbol	Explanation of the Symbol and Remarks
(1) (2) and (3)(4)(5)	Ps	Initial stages of the Psammosere extensive
	S	Scrub
	←	Within recent years these forests were connected.
	↢	Centuries ago these forests were connected.
		All Forest Bush and Scrub areas tinted pink.



Tablemountain Sandstone.
Bokkeveld.
Enon (Uitenhage beds) conglomerate
Knysna series (Ligniferous)
Alluvium
Precape rocks
Granite and Gneiss
Aeolian Drift.
UPPER MOLEN RIVIER
KLEIN LANG KLOOF
ANNEX KYKOERIE
KYKOERIE
KLIP RIVIER
DUBBEL BERG
FOREST RESERVE
HOOGE KRAAL FOREST RESERVE
FOREST RESERVE
MILLWOOD
LOWER STREEPBOSCH
REDLANDS
KRAAIBOSCH
BOKKEVELD
SOURFLATS
LEEUWEN BOSCH
PORTLAND
GOUNA FOREST
GOUNA COMMONAGE
HOOGE KRAAL
GRANITE
PRECAPE
ELANDS KRAAL
DRIFT
QUARRY WOOD
ZWARTE VALLEI OR BLACK LAKE
SEDGEFIELD
MOERASFONTEIN
WESTFORD
EASTFORD
ENON
KNYSNA
GROEN VALLEI
GANS-VLEI
BELVIDERE
BUFFELS VERMAAK
GERICKE POINT
ZWART RIVER
GOUKAMMA RIVER
WALKER POINT
BUFFALO BAY
ENTRANCE KNYSNA
INDIAN OCEAN
No 2
MAP OF KNYSNA WEST
SCALE 1 inch = 1600 yards

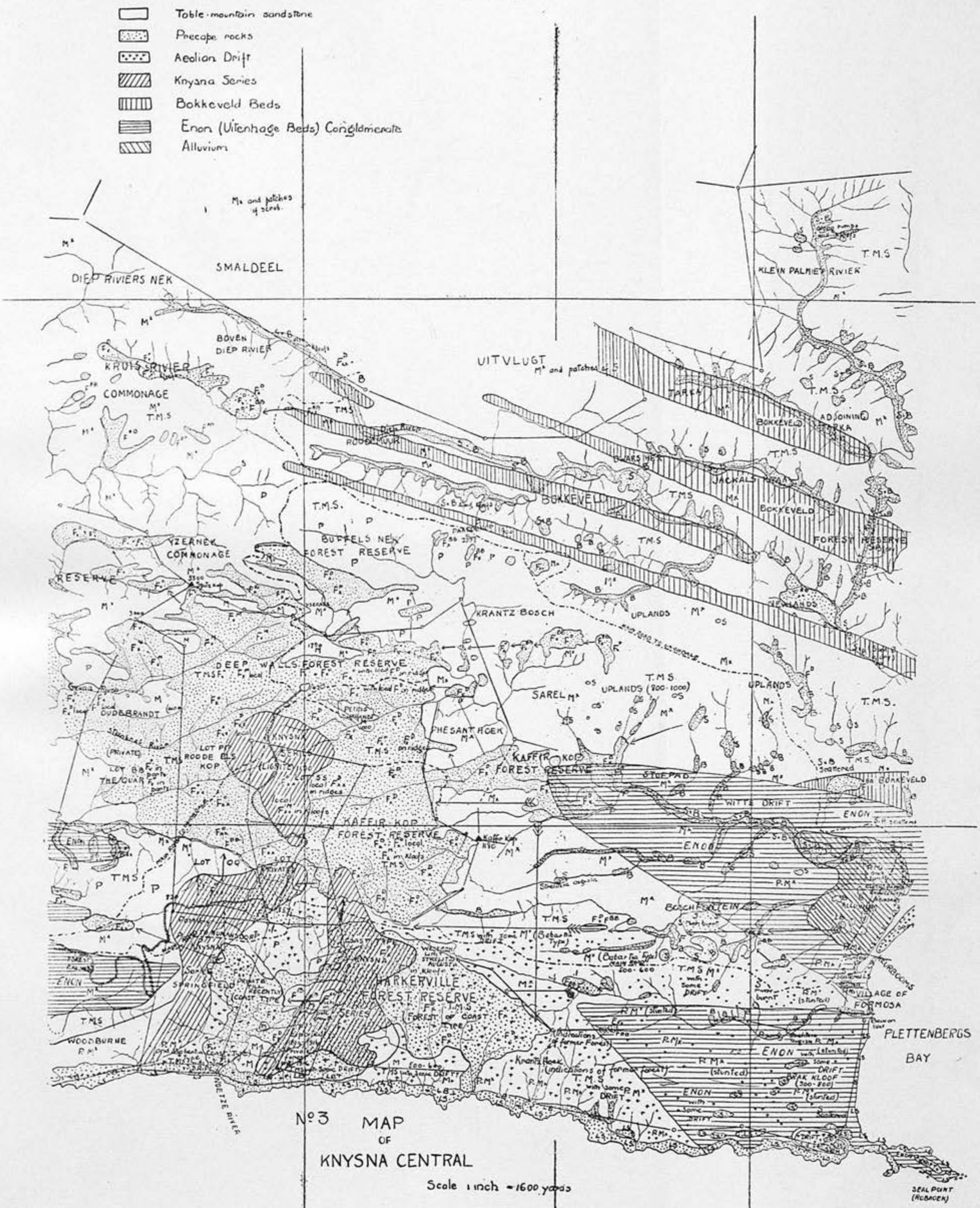
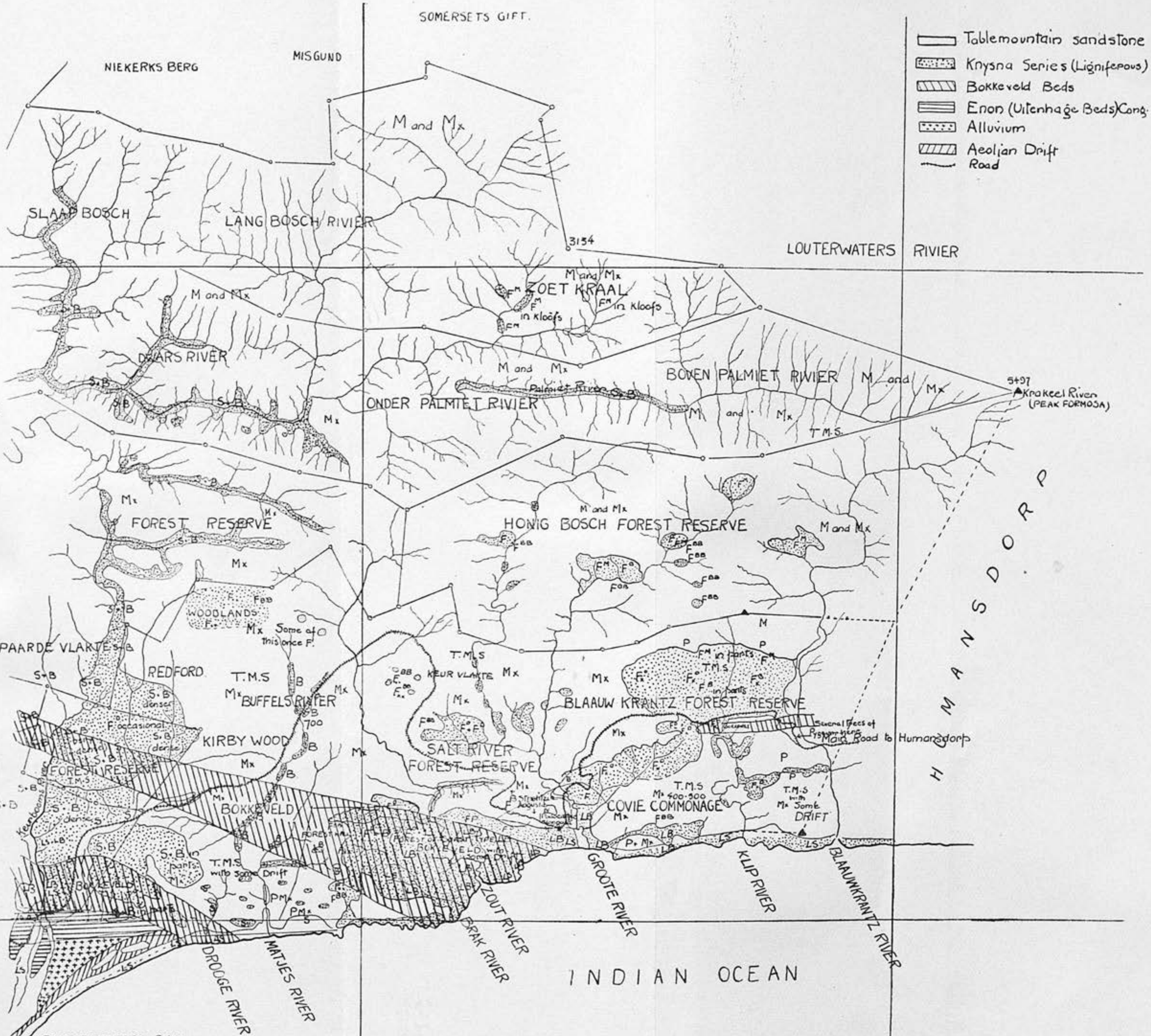
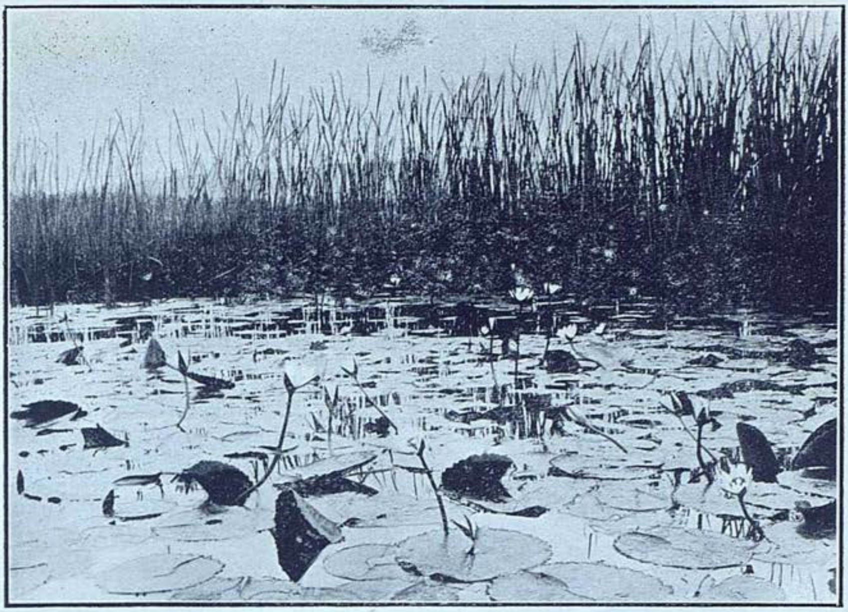


Table-mountain sandstone
Precape rocks
Aeolian Drift
Knysna Series
Bokkeveld Beds
Enon (Uitenhage Beds) Conglomerate
Alluvium
SMALDEEL
DIEP RIVIERS NEK
BOVEN DIEP RIVIER
KRUIS RIVIER
COMMONAGE
UITVLUGT
KLEIN PALMIET RIVIER
TARKA
ADJOINING TARKA
BOKKEVELD
JACKALS KRAAL
BUFFELS NEK FOREST RESERVE
YZERNEK COMMONAGE
RESERVE
FOREST RESERVE
KRANTZ BOSCH
UPLANDS
DEEP WALLS FOREST RESERVE
SAREL
UPLANDS (200-1000)
DUDBRANDT
PHESANT HOEK
KAFFIR KOP FOREST RESERVE
STEEPAD
WITTE DRIFT
ENON
BOSCHFONTEIN
HARKERVILLE FOREST RESERVE
VILLAGE OF FORMOSA
PLETTENBERGS BAY
WOODBURNE
NOETZIE RIVER
BRAK KLOOF
SEAL POINT (ROBBERG)
No3 MAP OF KNYSNA CENTRAL
Scale 1 inch = 1600 yards

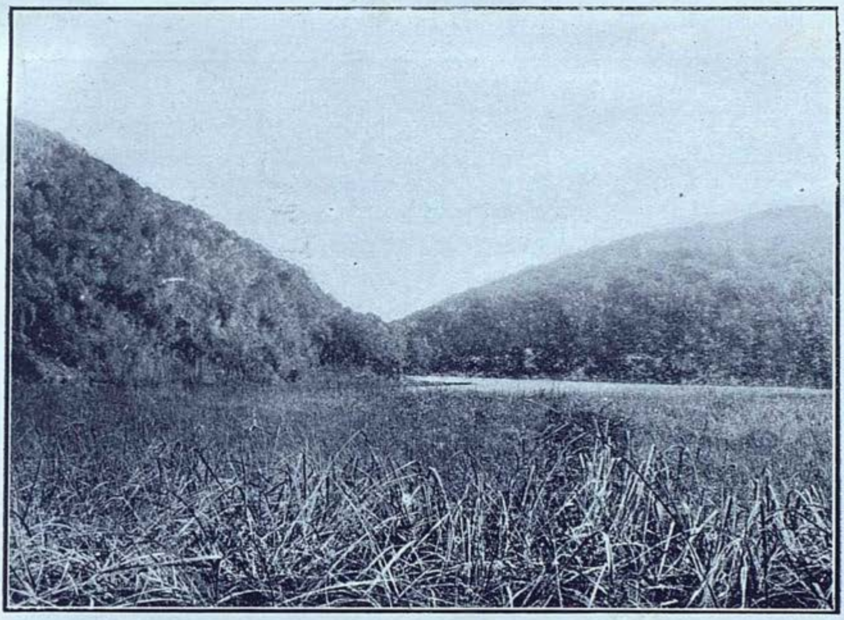


MAP
OF
KNYSNA EAST

NO 4.   Scale 1 inch = 1600 yards.

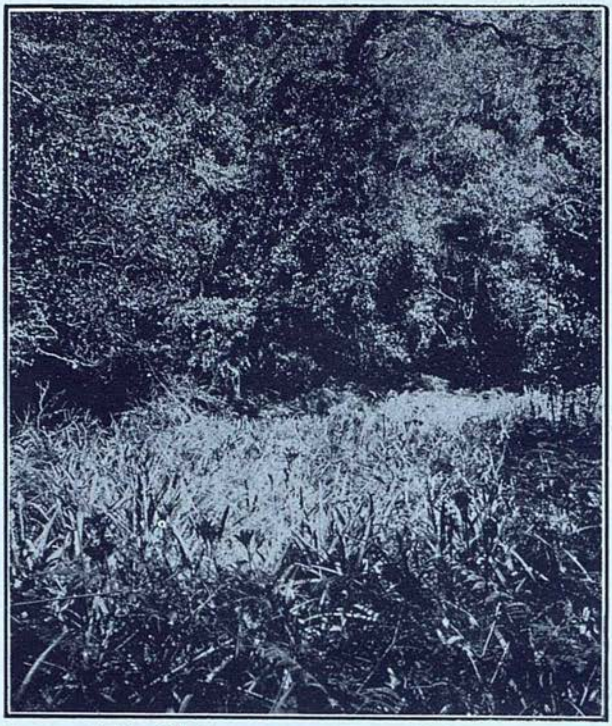


(1) Initial stages of the Hydrosere:
Nymphaea stellata in foreground, Typha capensis behind. Gouwkamma River.

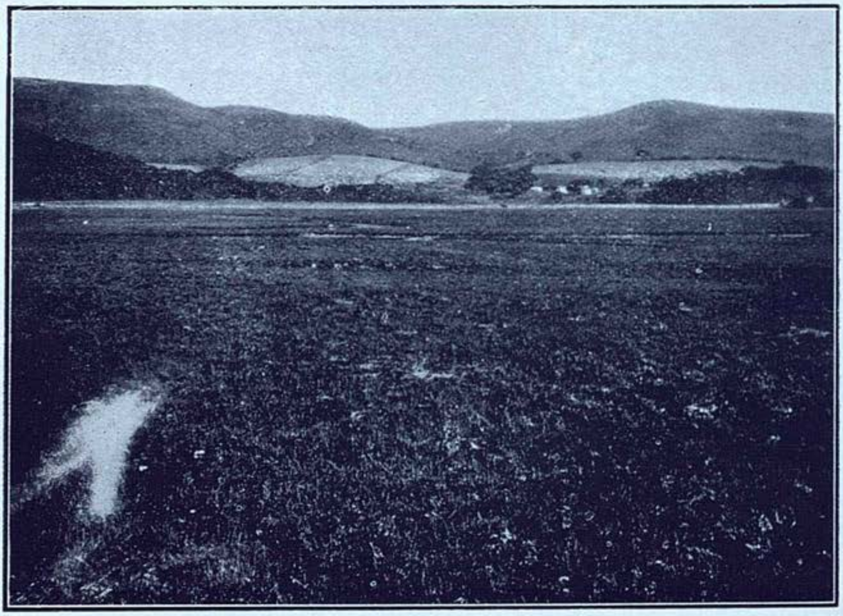


(2) Initial stages of the Hydrosere:
The stage of tall Cyperaceae: Mariscus riparius, Mariscus congestus, Cyperus textilis, Cladium jamaciense, Carpha glomerata, Scirpus littoralis, Eleocharis limosa, Fuirena spp., Pycreus polystachyus.

In background: *Xerocline* with Littoral Scrub, on left; *Mesocline* with Littoral Bush, on right. Noetzie River.

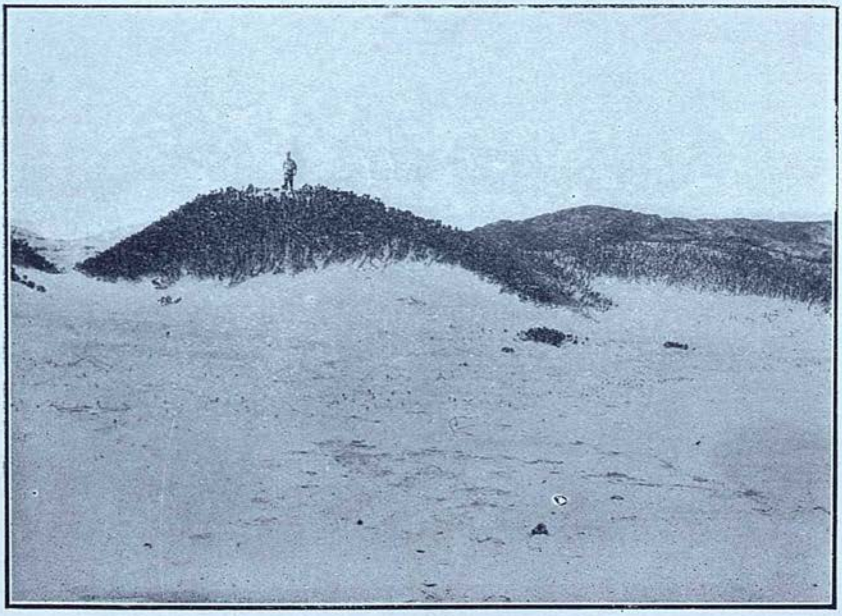


(3) Initial stages of the Hydrosere:
Cyperaceae (chiefly Mariscus congestus and Cyperus tenellus) and Hydrocotyle asiatica in centre, and the endemic Vallota purpurea on the margins. The Vallota are in flower.—Lilyvlei Forest, Couna.

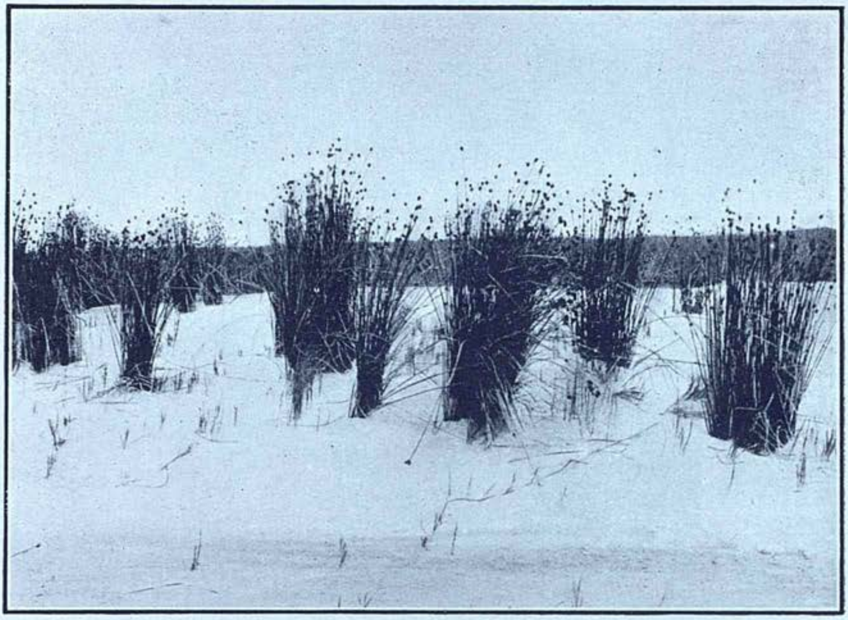


(4) Initial stages of the Halosere:
Salicornia natalensis consocies, Chenolea diffusa consocies, and Salicornia natalensis-Chenolea associes, in foreground. Psammophilous Macchia, Littoral Scrub, and Littoral Bush in background.—Estuary of Knysna River, eastern side.

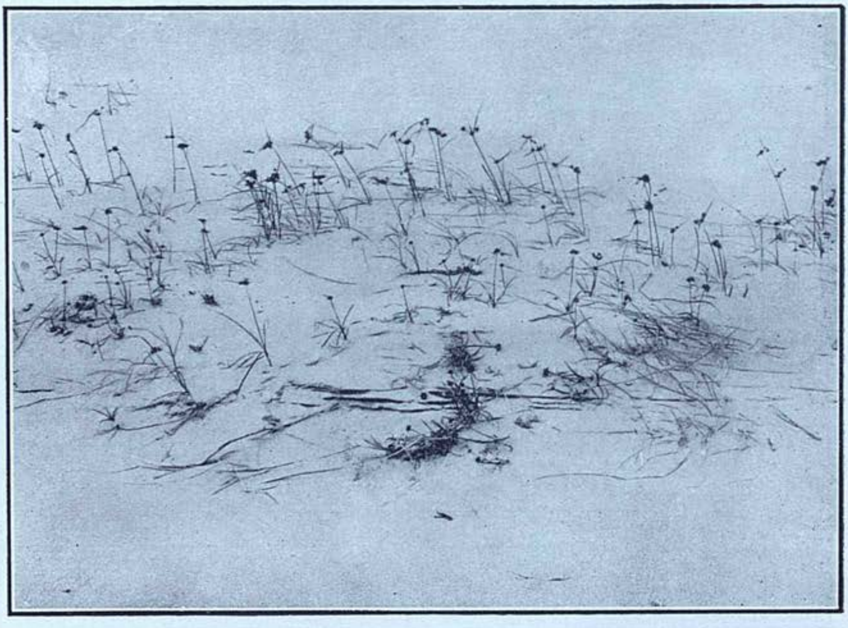
(5) Initial stages of the Psammosere:
Scaevola (lobelia Murr.) Thunbergii E. & Z. consocies; the plant is in flower and in heavy fruit. Note the prostrate stems, which form adventitious roots, and so fix the sand. The entire absence of plants of other species is a feature of interest.—Buffalo Bay.



(6) Initial stages of the Psammosere:
View of small dunes formed and fixed by Scaevola. Pioneer Scaevola in foreground; many of these seedlings are lesioned by the high temperature of the surface of the sand, and will die.—Buffalo Bay.

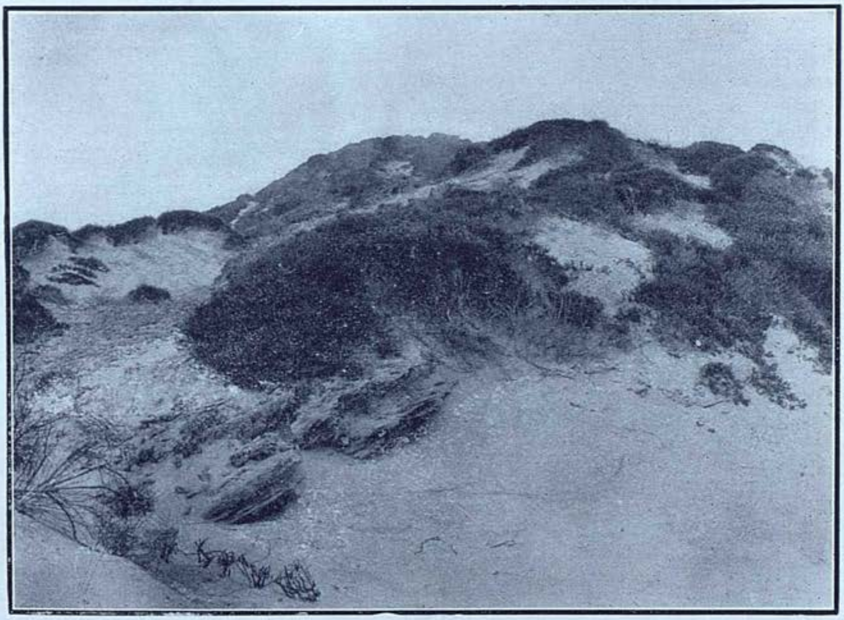


(7) Initial stages of the Psammosere:
Scirpus nodosus consocies on moister sand; pioneer Stenotaphrum glabrum is seen in the foreground. (In the background is a dense associes of Typha capensis and Fuirena hirta, standing in water.—Buffalo Bay.



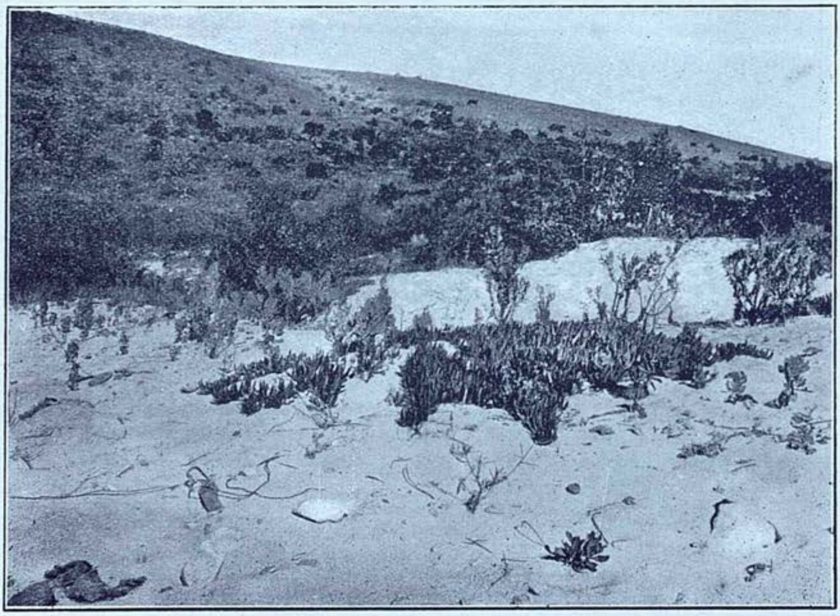
(8) Initial stages of the Psammosere:
Pinoeer Mariscus congestus on a moister site at the base of a sand dune. The plant is stunted and sub-succulent compared with plants of the same species occurring in or near open water inland.—Buffalo Bay.

(9) Initial stages of the Psammosere:
Cryptostemma (Microstephium) niveum consocies; the large, heavy canescent foliage efficiently covers the sand.—Buffalo Bay.

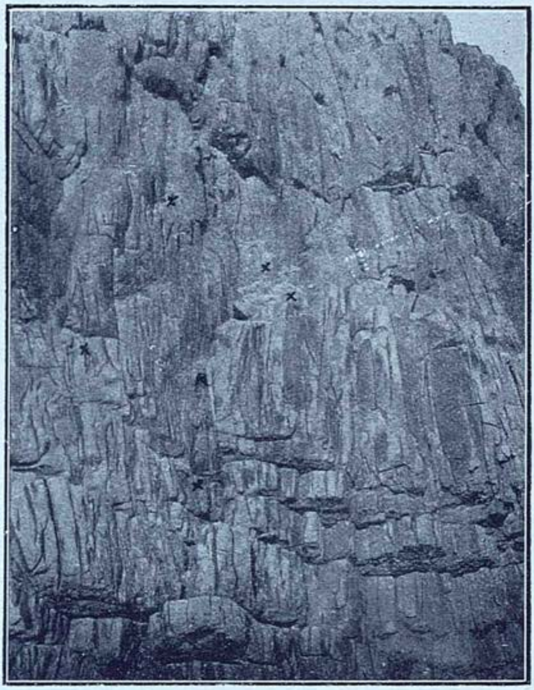


(10) Medial stages of the Psammosere:
Stunted Psammophilous Macchia—principally Metalasia muricata, Phylica lasiocarpa, Erica speciosa, Psoralea bracteata, Aspalathus spp. Dune limestone formed as the result of deposition of carbonate of lime derived from shells and other remains of marine organisms, is seen in the foreground.—Buffalo Bay.

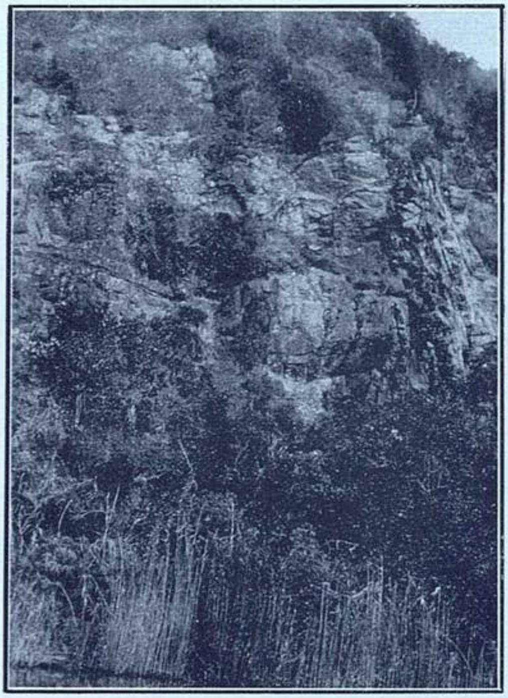
(11) General view of the coast immediately west of the Groot River, Knysna district, showing the row of littoral dunes bearing Psammophilous Macchia and Littoral Scrub on their crests, and Littoral Scrub and Littoral Bush on their landward slopes. Much of the Littoral Bush has been cleared for agricultural purposes. Burnt Macchia rich in Aristea and Gladiolus in foreground.



(12) The Psammosere inland:
In foreground: Mesembryanthemum edule, M. acinaciforme, Othonna amplexicaulis, Rubus rigidus, on white sand derived from Bokkeveld and Table Mountain beds adjacent. In background, mixed Psammophilous Macchia and Scrub species.—Rooimuur, district Knysna.

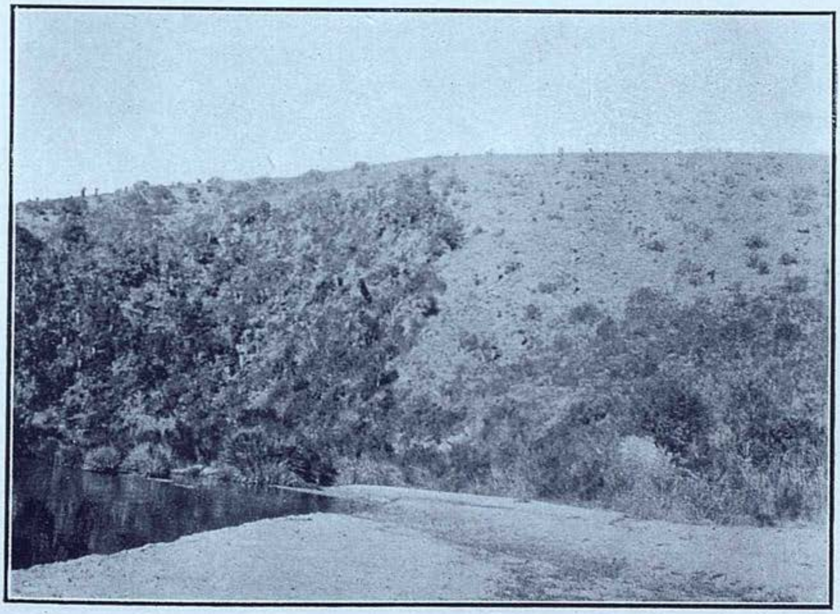


(13) The Lithosere at the coast; at the ×'s are pioneer plants of Gazania uniflora finding slender roothold in the crevices in the faces of the sheer, rocky cliffs.—Coast immediately east of the Noetzie River. The rocks are of Table Mountain Sandstone.

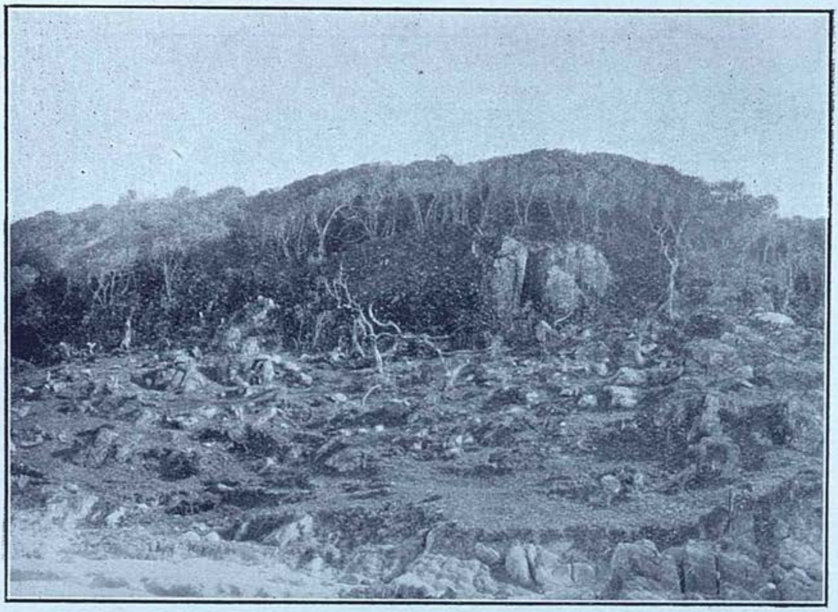


(14) Lithophilous vegetation, Xerocline, Noetzie River. The rocky sites in the centre are held by Crassula perfossa, C. platyphylla, C. rubricaulis, C. rosularis, C. clavifolia, Cotyledon orbiculata, Senecio junceus, Helichrysum paniculatum, Gazania uniflora, Asparagus africanus. Above is Scrub, below Bush, and in the foreground, Hydroseral stages—Phragmites and Cyperaceae.

(15) Lithophilous Macchia on Enon conglomerate; Bush below the white beds.—Eastford, Knysna.

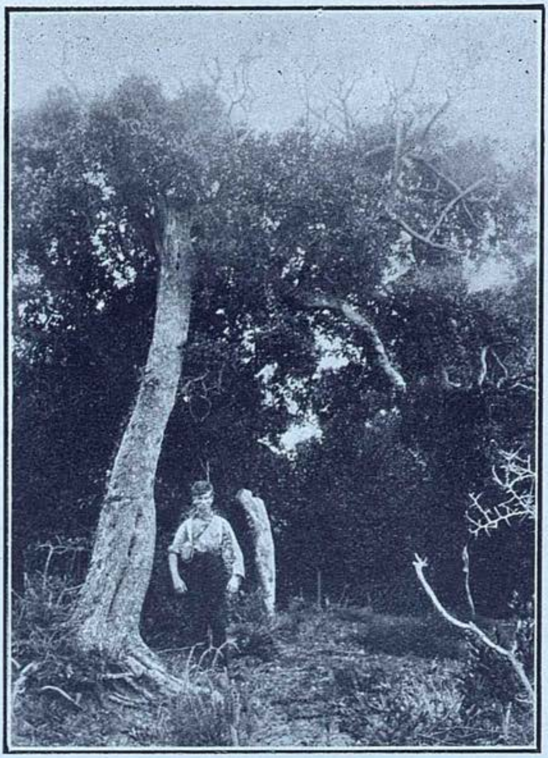


(16) Rocky hillside, Rooimuur, Lithophilous Macchia (including spaces of Themeda triandra) and scattered Aloe ferox on right, and Inland-type Scrub on left.



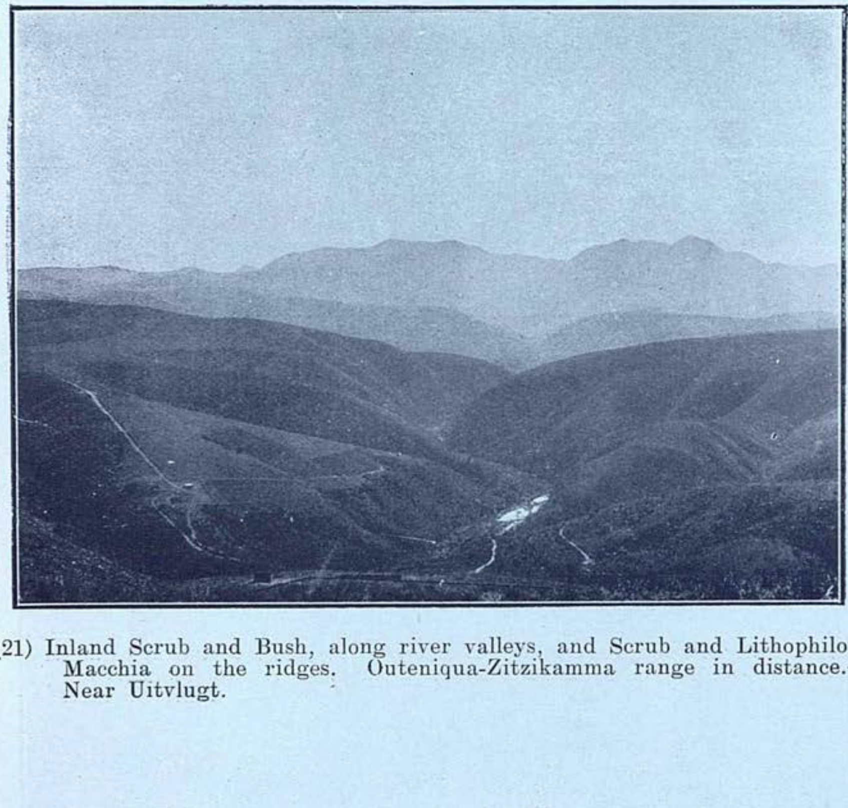
(17) Littoral Scrub, within 300 yards of sea, Noetzie. The principal species forming the community are Elaeodendron Kraussianum, Sideroxylon inerme, Plectronia ventosa, Pterocelastrus variabilis, Olea capensis, Tarconanthus camphoratus, and stunted Podocarpus elongata and P. Thunbergii, the undergrowth consisting of Knowltonia spp., Hypoestes spp., and Aspidium capense. In foreground, site of cleared Littoral Scrub, with Stenotaphrum glabrum dominant, and scattered Knowltonia glabricarpellata. The Scrub is 8 to 12 feet in height.

(18) Littoral Scrub—margin 20 feet above the sea. Elaeodendron Kraussianum on left, Pterocelastrus variabilis on right, with tangle formed by Ficus capensis, Capparis citrifolia, and Scutia Commersonii, in centre.—Noetzie.

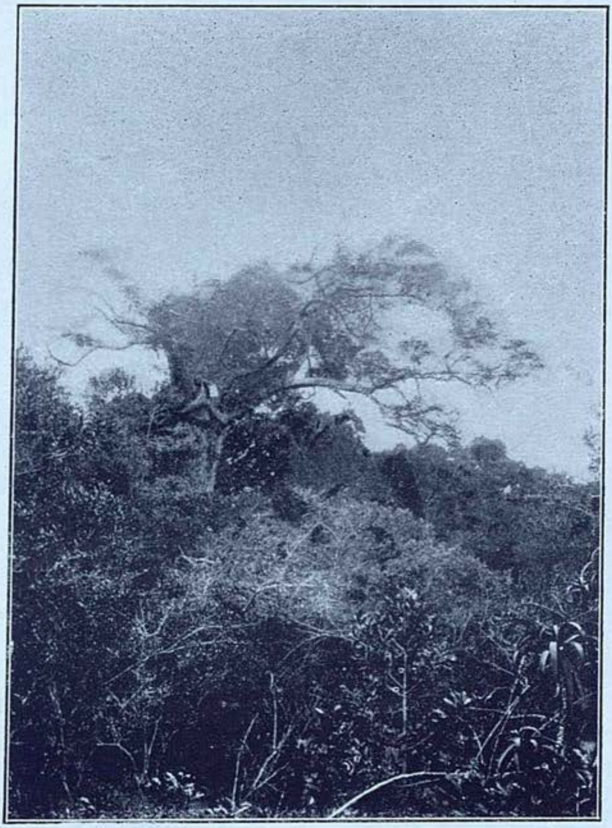


(19) Littoral Scrub: Sideroxylon inerme in foreground, much malformed by sea winds; behind, mixture of Pterocelastrus variabilis, Acokanthera venenata, Doyvalis rhamnoides, Olea exasperata, and other spp.—Buffalo Bay.

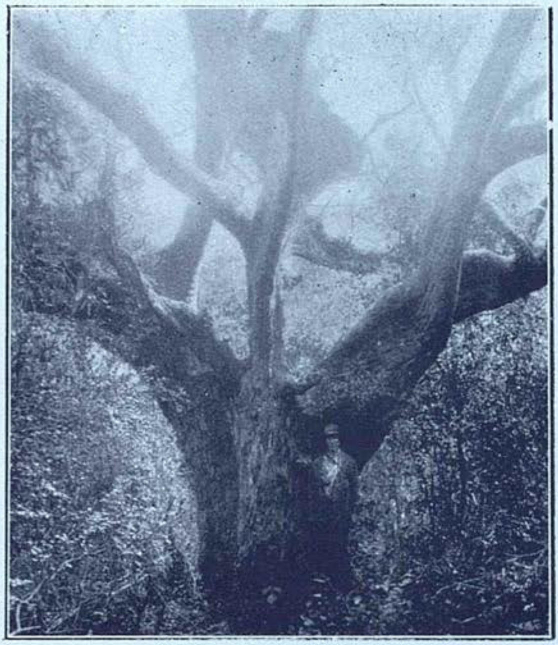
(20) Littoral Scrub: interior, with Sideroxylon inerme in foreground; note the open, dry nature of the ground.—Buffalo Bay.



(21) Inland Scrub and Bush, along river valleys, and Scrub and Lithophilous Macchia on the ridges. Outeniqua-Zitzikamma range in distance.—Near Uitvlugt.

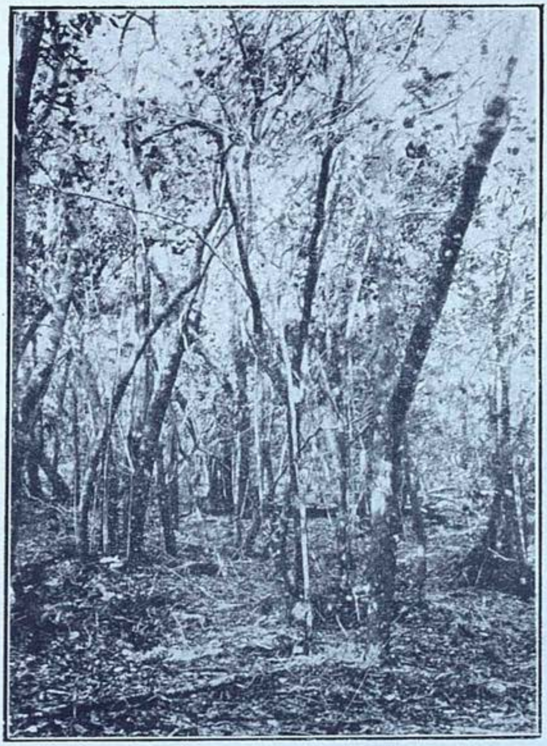


(22) Scrub in foreground merging into Bush in background. The large tree is Podocarpus elongata L'Herit. of full height, 35 feet. In foreground are Aloe arborescens, Myrsine melanophleos, Rhus lucida, Pterocelastrus variabilis.—On Eastford Estate.

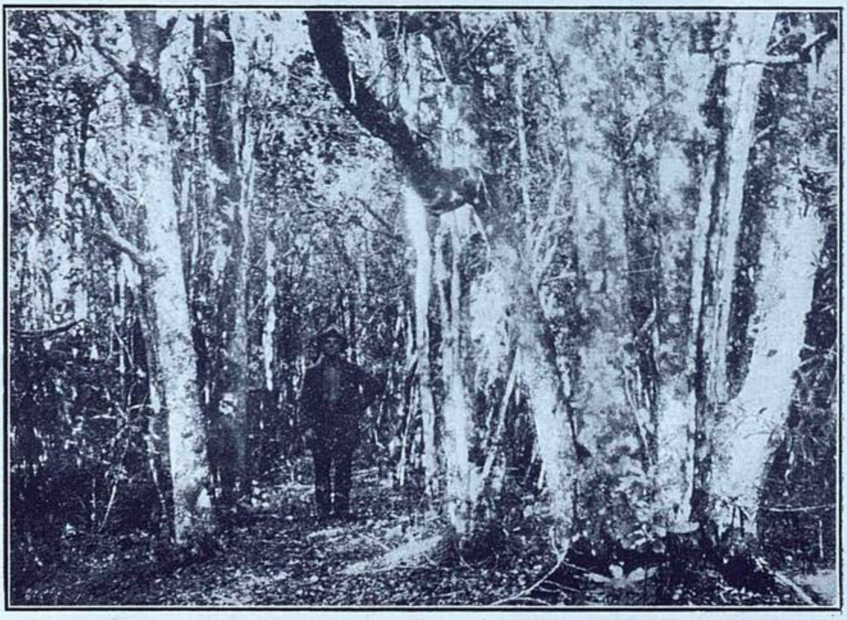


(23) Littoral Bush: Interior, on an exposed, shallow-soiled ridge within ½ mile of the sea. Grotesque Podocarpus elongata L'Herit., of girth (at 4¼ feet from ground) 14 feet, its bole being 6 feet in length only; the height to the top of the crown is 30 feet. The tree is a female which fruits profusely, but absolutely no regeneration has been found near it. The associated species are principally Elaeodendron Kraussianum, E. capense, Euclea macrophylla, Plectronia ventosa, and Trichocladus crinitus.—Harkerville Reserve.

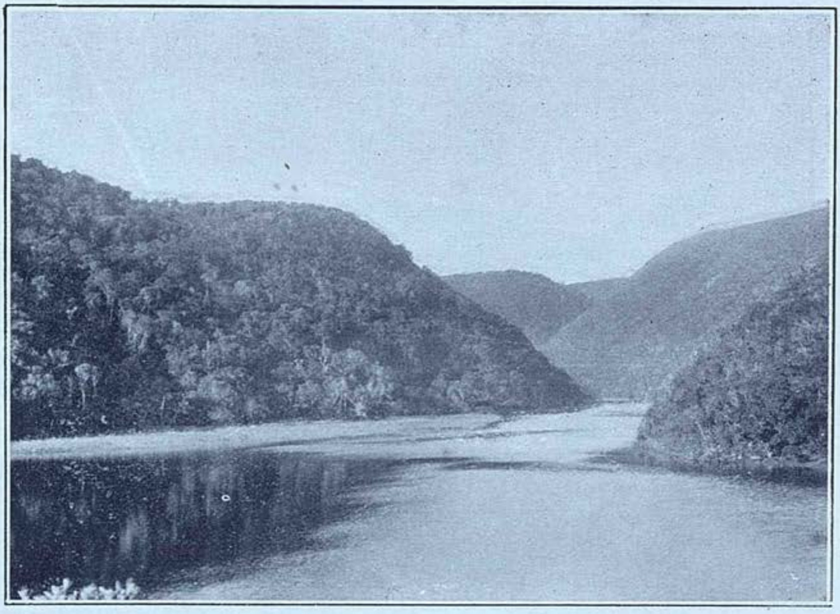
(24) Littoral Bush: Interior, in a well-protected, deep-soiled position. Podocarpus elongata L'Herit., 5 ft. by 35 ft., in centre; note the flattened nature of the branches—the influence of the sea-winds. A small Myrsine melanophleos appears to the right, and behind it a second P. elongata. The lianes are Rhoicissus capensis, Cissus cuneifolia, Scutia Commersonii, Secamone Alpini, Cynanchum spp., Pyrenacantha scandens, and Clematis Thunbergii. On the ground are Haemanthus puniceus and Hypoestes aristata.—Harkerville Reserve.



(25) Littoral Bush: interior. Elaeodendron Kraussianum, Plectronia ventosa, Myrsine melanophleos, and stunted Podocarpus Thunbergii Hook. Regeneration very sparse.—Harkerville Reserve.

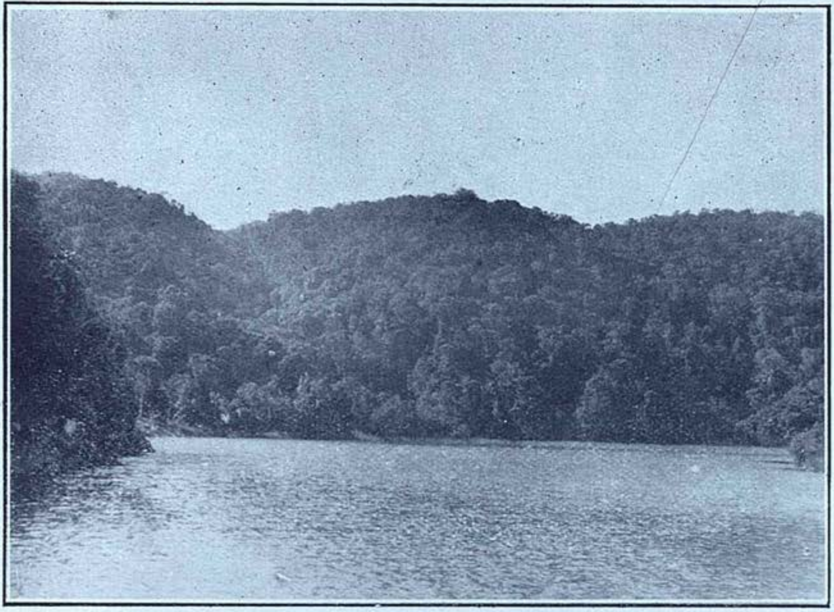


(26) Inland Bush: interior. Pterocelastrus variabilis, Myrsine melanophleos, Plectronia obovata, and Trichocladus crinitus. Regeneration very sparse.—Harkerville Reserve.

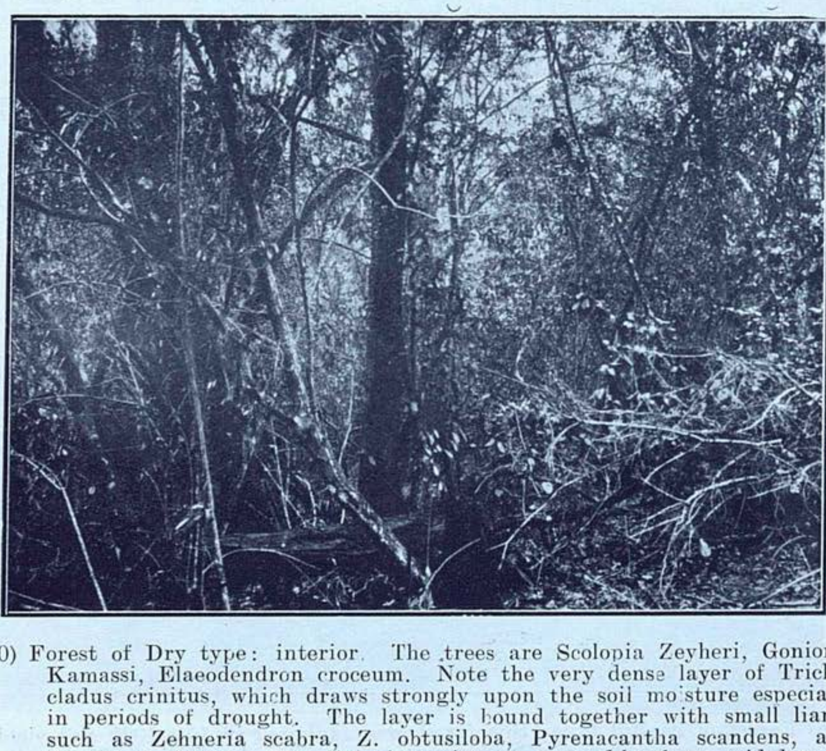


(27) Forest of coastal type on left (rich in Podocarpus spp., Olea laurifolia, Elaeodendron croceum, E. Kraussianum, Rhus laevigata, Calondendron capense, Ekebergia capensis, Celtis rhamnifolia) and Scrub and Bush on right—the Scrub covering all but the most sheltered and the best-soiled positions. The left slope experiences a S. E. aspect, and is the *mesocline*; the right slope experiences a N.W. aspect and is the *xerocline*.—Along the Noetzie River.

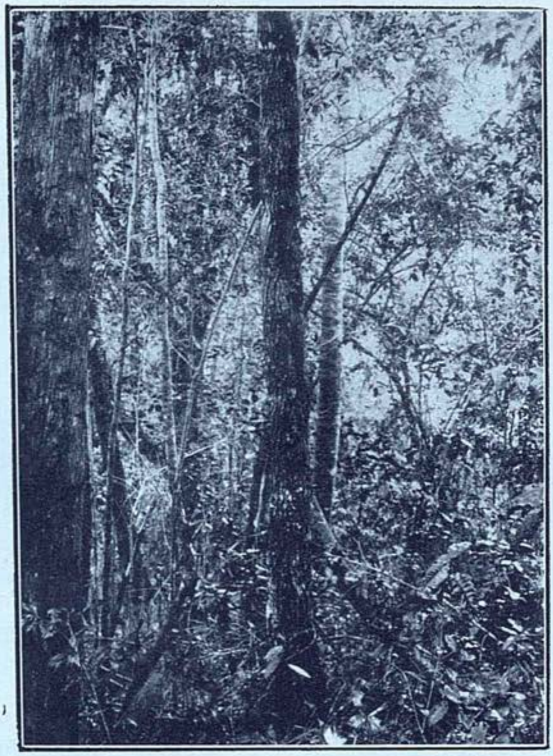
(28) Forest of coastal type; this forest was exploited in 1918-1921 and yielded some good timber (Podocarpus spp., Olea laurifolia, Elaeodendron croceum, and Myrsine melanophleos) despite the short height-growth of the trees. Phragmites communis and Scirpus littoralis along the margins of the river.—Noetzie.



(29) Forest of coastal type, which through excessive felling (the forest is private property) has been converted into Littoral Bush in most parts.



(30) Forest of Dry type: interior. The trees are Scolopia Zeyheri, Gonioma Kamassi, Elaeodendron croceum. Note the very dense layer of Trichocladus crinitus, which draws strongly upon the soil moisture especially in periods of drought. The layer is bound together with small lianes such as Zehneria scabra, Z. obtusiloba, Pyrenacantha scandens, and Secamone Alpini. The light-intensity at ground-level at mid-day on a bright, cloudless day is as low as 1/350 that of full sunlight. Regeneration of tree spp. is lacking.

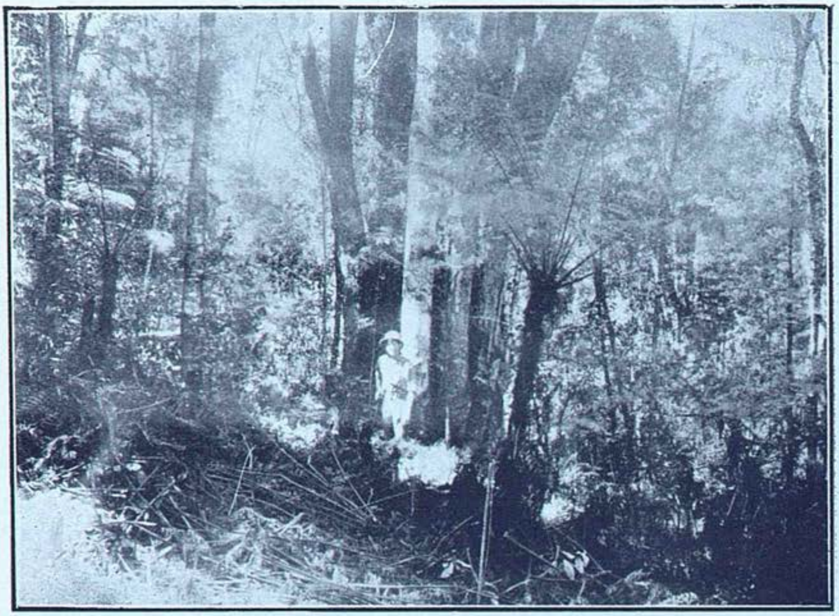


(31) Forest of medium-moist type: interior. Bole of Podocarpus Thunbergii on left; the light-coloured poles are Ocotea bullata; the central pole is Gonioma Kamassi. The seedlings with the large leaves, on the right, are those of Ocotea bullata.—Deepwalls.

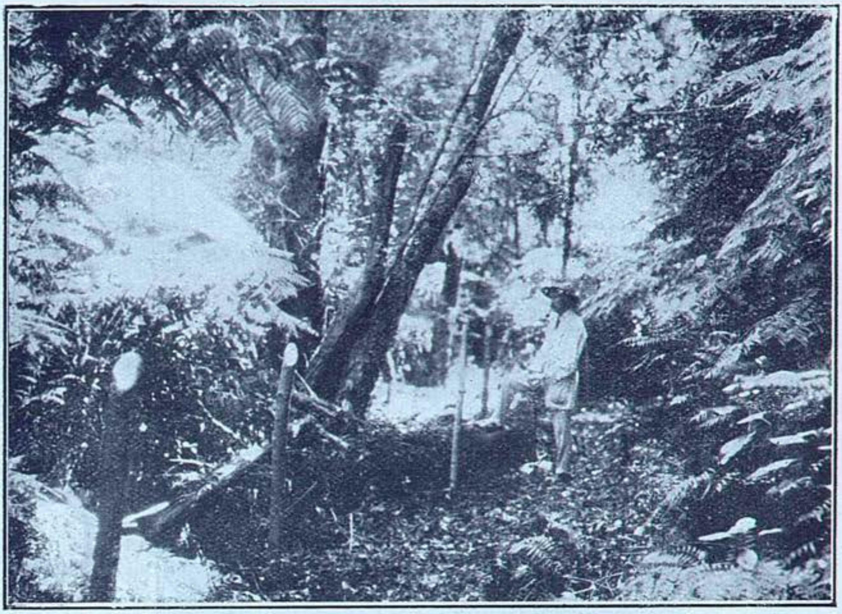
(32) Forest of medium-moist type, with Trichocladus crinitus layer removed; the trees are principally Podocarpus Thungergii and Olea laurifolia, while the regeneration is mainly that of Ocotea bullata and Podocarpus Thunbergii. Blechnum punctulatum fronds in central foreground, those of B. capense on right.

The light-intensity below the removal of the Trichocladus was 1/300–1/400 at ground-level, at noon on clear days; after removal it was 1/20–1/40. Regeneration has improved since the removal of the shrub.

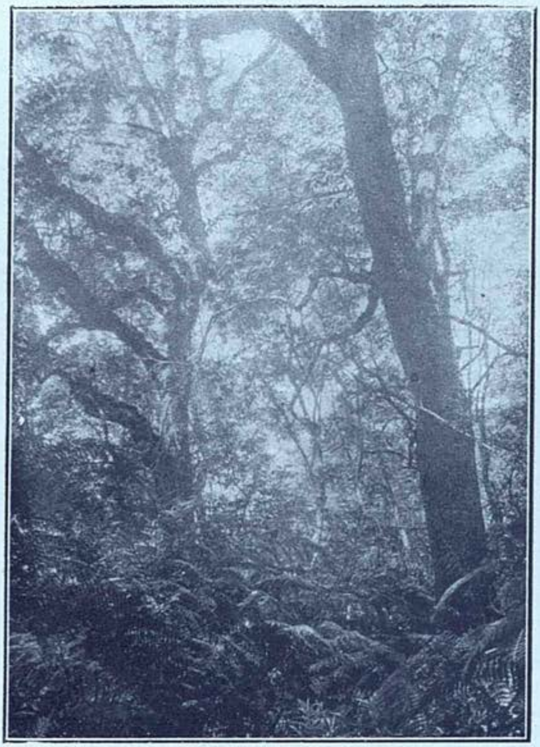
(33) Forest of medium-moist type, where Trichocladus crinitus is not so dense, its place being taken by tall Blechnum capense (see fronds in foreground). Note the abundant pole regeneration of various species, principally Podocarpus Thunbergii and Ocotea bullata. Owing to the abundant Blechnum there are few young seedlings on the ground.—Deepwalls.



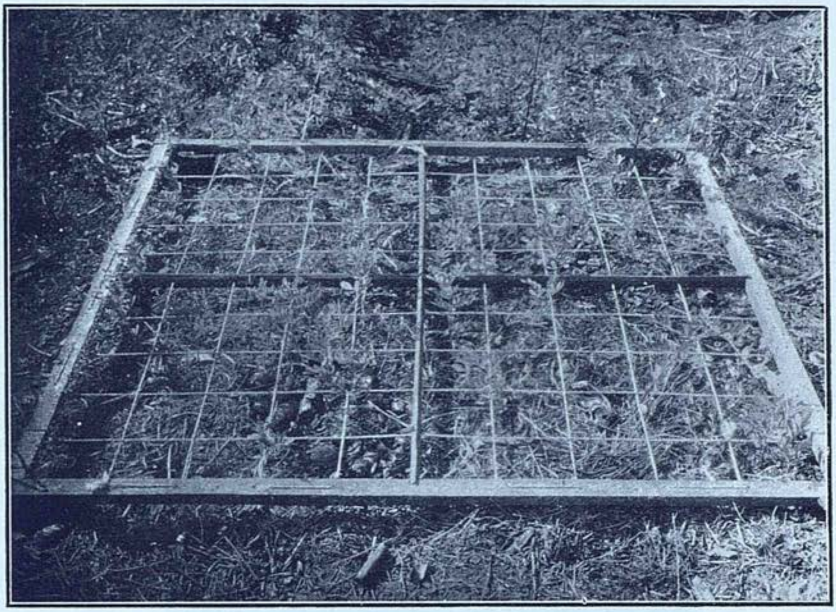
(34) Forest of moist type, the Hemitelia capensis layer being removed so as to assist regeneration of the area. Several Hemitelia are seen. The large tree (made up of 6 gourmand-coppice shoots) is Ocotea bullata, those trees to the left are Cunonia capensis. Owing to the strong reaction of the Hemitelia on the light-intensity (cutting down the light at ground-level to 1/800–1/1500 at noon on bright days) there is practically no regeneration of tree species on the ground. Removal of the fern increases the light-intensity 8- to 12-fold.—Vanhuyssteenbosch.



(35) Forest of moist type: boles of small individuals of Platylophus trifoliatus in centre; Hemitelia capensis layers left and right—the fern has been removed from the centre to enable the photograph to be taken. The upright poles are truncheon-cuttings of Platylophus. The mean holard at 6-12 inches, under the ferns, is 170% on dry weight; the light-intensity under the ferns at midday is 1/1200; the pH value for the soil solution is 4.4. Regeneration is absent.—Deepwalls.

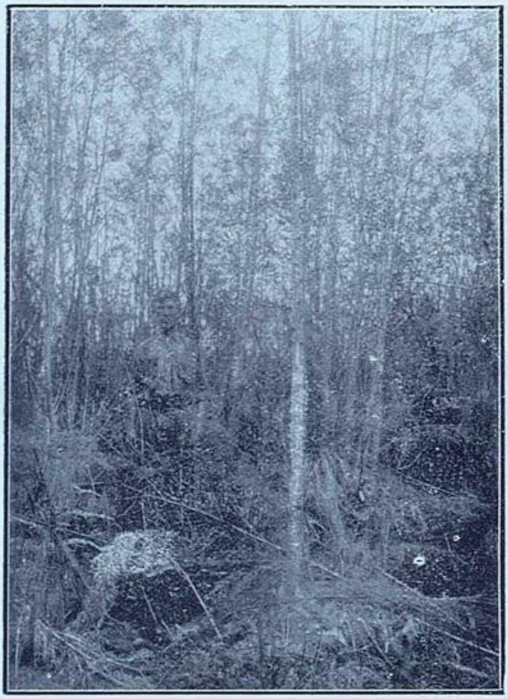


(36) Better class montane forest of moist type: Cunonia capensis in foreground, Platylophus trifoliatus in back. Note the dense layers of Hemitelia capensis, Marattia fraxinea, and Todea barbara. Under the ferns the conditions are exceedingly moist, acid, and dark. Regeneration is sparse.—3,200 ft. Deepwalls.

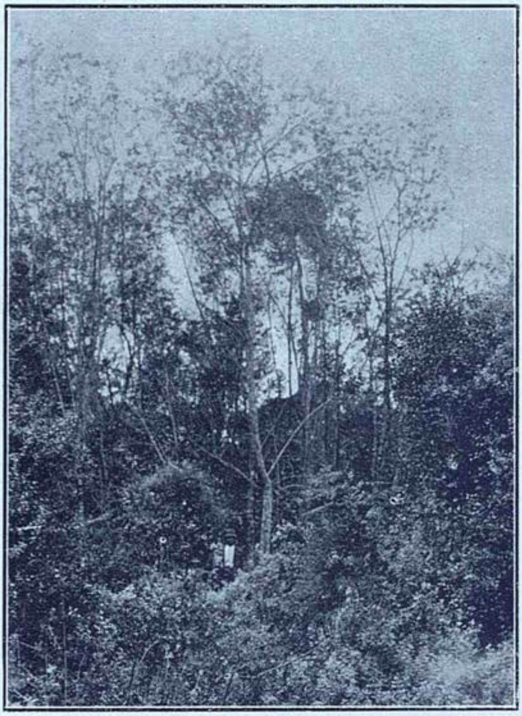


(37) The establishment of communities of Virgilia capensis on burnt sites; note the numerous seedlings (7 days old) on 1 square-metre of burnt soil.—Deepwalls. (The hard seed of Virgilia may remain dormant for many years if not stimulated to germinate by heating or bruising.)

(38) 3 4 years old consocies of Virgilia capensis, along the burnt margin of climax forest. The trees are 12-18 feet high and 4 to 8 inches in girth at breast-height. Under canopy of the Virgilia seedlings of the forest trees proper, appear, and grow vigorously. Slashed fire-belt in Macchia, in foreground.



(39) Virgilia capensis consocies, 3-4 years old. Note the dead and dying Thamnochortus racemosus and Pteridium aquilinum under cover of the tree. The banded trees are under observation for the collection of girth-increment data. Virgilia trees at this stage grow at the rate of $\frac{3}{4}$ to 1 inch per annum (girth).

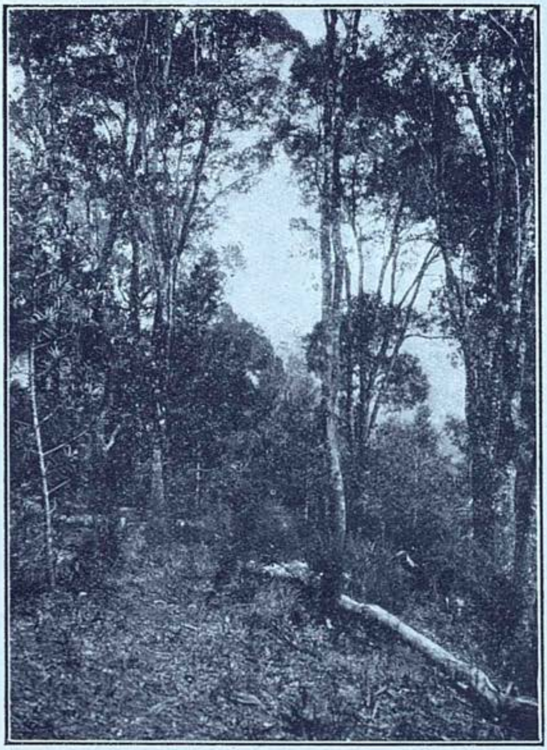


(40) Natural re-establishment of forest on burnt sites, through agency of Virgilia capensis. Virgilia in background, Helichrysum petiolatum, Pteridium aquilinum, and Cliffortia odorata, in foreground. Under the Virgilia are numerous seedlings of tree species; on the weed-clad area, no seedlings occur.

(41) Virgilia capensis forming a large and close consocies; the trees appeared after a forest-destroying fire, in 1911.

Their average height is 45 feet, and their girths range from 6 inches (suppressed) to 36 inches (dominant). Under their canopy are hundreds of seedlings of Podocarpus Thunbergii, Curtisia faginea, and other spp. Relict patches of Helichrysum petiolatum and Rubus fruticosus (exotic) remain, but do little harm to the young trees.—Gouna.

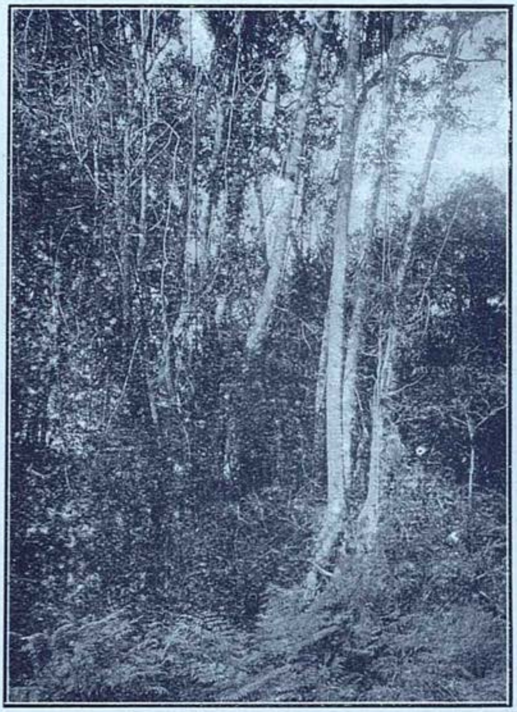
(42) A site cleared of Gleichenia polypodioides Sm. and then fired; in the soil, seed of Virgilia capensis had lain dormant over 30 years; several weeks after the fire thousands of seedlings of this tree appeared on the ground—*vide* foreground.—Deepwalls.



(43) Olinia cymosa consocies, with abundant regeneration of Podocarpus Thunbergii Hook in background.—Deepwalls.

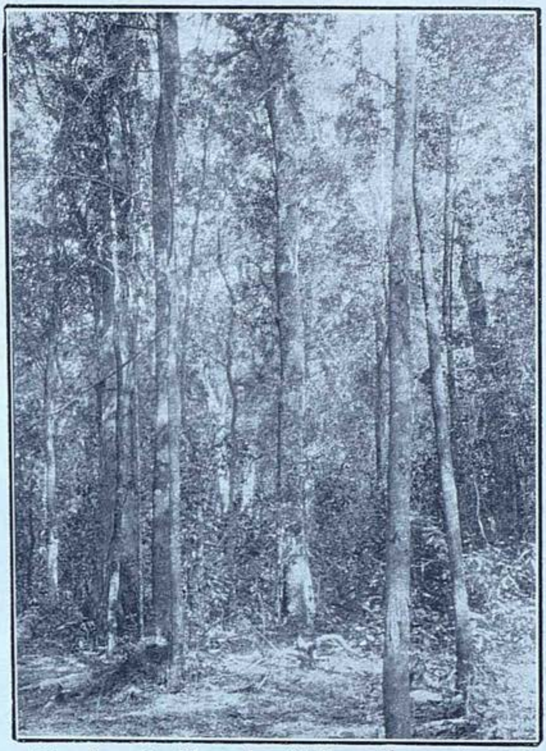
(44) The giant crowns of Podocarpus elongata L'Herit.; the trees are growing in a deep ravine.—Grootriver.

(45) A small consociation of Ocotea bullata; the ground flora consists of Pteridium aquilinum and Plectranthus fruticosus. Scattered Ocotea consociations are not uncommon along roadsides.

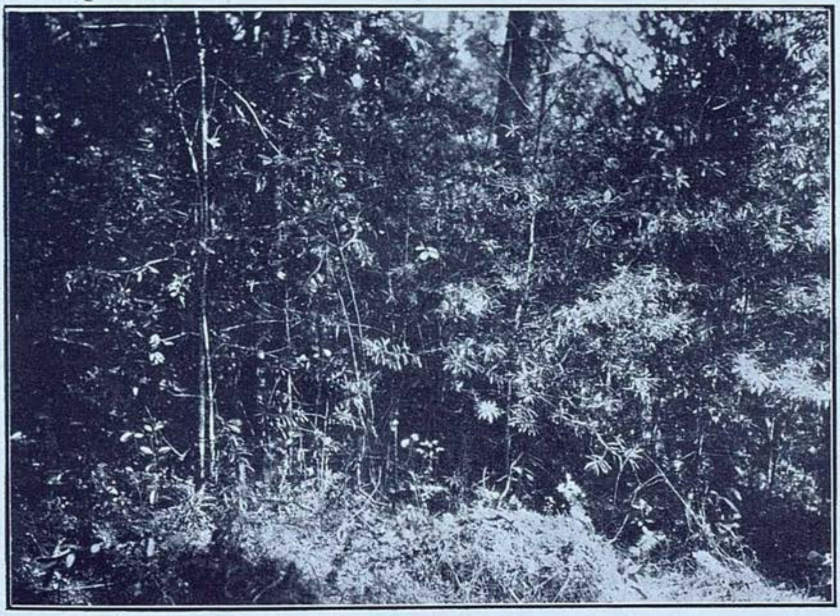


(46) Gourmand-coppice of Ocotea bullata; the shoots in time form their own roots and become independent of the main stem, which often dies back on establishment of the coppices.

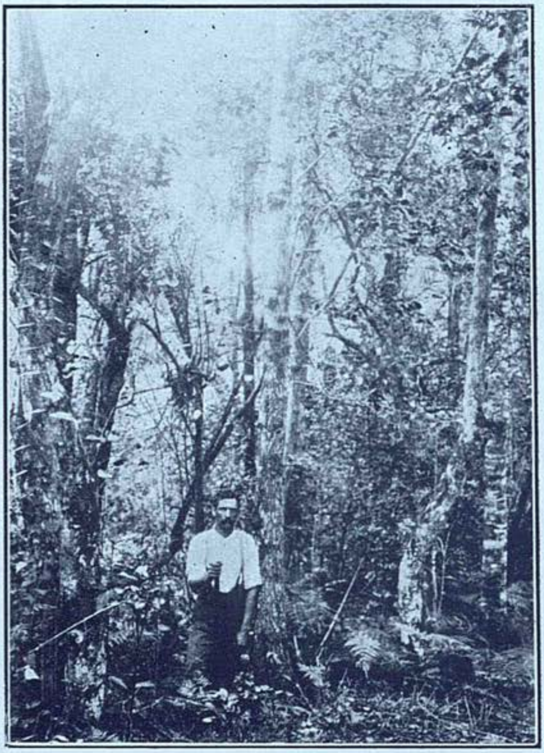
The lianes are Clematis Thunbergii, Secamone Alpini, and Ficus Burtt-Davyi. In foreground, dense Pteridium aquilinum and Plectranthus fruticosus.—Deepwalls.



(47) Podocarpus Thunbergii—Olea laurifolia—other spp. association, with scattered Faurea McNaughtonii. The central bole is that of Faurea.—Lilyvlei Forest, Gouna.

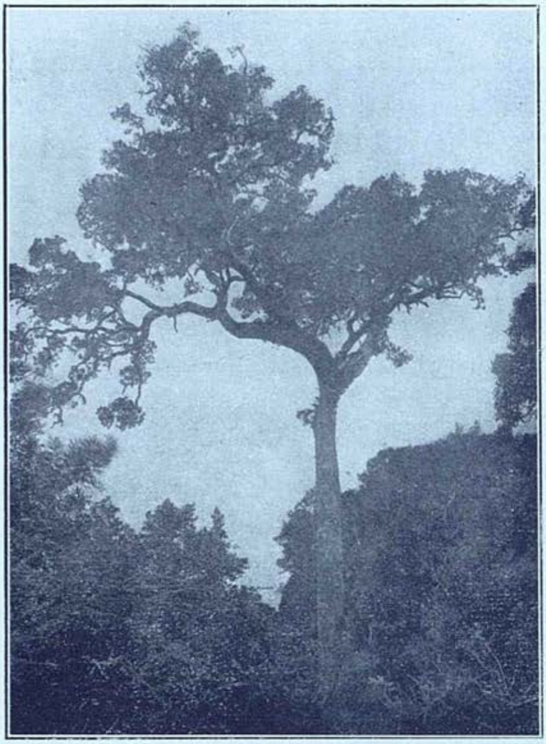


(48) Podocarpus Thunbergii—Olea laurifolia—other spp. association: excellent natural regeneration of Podocarpus Thunbergii in foreground.—Deepwalls.



(49) Podocarpus Thunbergii—Olea laurifolia—other spp. association, showing Nuxia floribunda on left, Gonioma Kamassi in the centre, Apodytes dimidiata on the right, and dense Trichocladus crinitus in the background. The liane ascending the bole of Nuxia on the left is Pyrenacantha scandens. Regeneration of tree species is locally frequent.—Deepwalls.

(50) Podocarpus Thunbergii—Olea laurifolia association. Bole of a large Olea is seen on the right, bole of a Podocarpus on left. The open nature of the community in the foreground, is due to cattle trespass. The pole stages are principally composed of Podocarpus Thungergii regeneration. —Deepwalls.



(51) Podocarpus elongata L'Herit. Girth at 4¼ feet, 14 feet; height of clear bole, 60 feet; full height, 120 feet—a relict tree in climax forest, its fellows being felled.—Deepwalls 1,400 feet.

(52) A 1 square-metre quadrat set out on the floor of a Podocarpus Thunbergii —Olea laurifolia—other spp. association; there are over 400 2-year-old Olea laurifolia seedlings on the quadrat, as well as numerous plants of Impatiens capensis, Carex aethiopica, and Juncus lomatophyllus.

The majority of the Olea seedlings will succumb to the ravages of fungi (Microthyriaceae, Perisporiaceae, and Corticium vagum) and insects (Coccidae).

(53) A felled Podocarpus elongata L'Herit., showing the high degree of damage caused by its fall; the widespread and heavy crowns break down numerous trees, and pile up branchwood over 10 feet in depth; regeneration of forest trees is unable to establish itself on such sites for periods ranging from 5 to 20 years.—Climax Forest, Deepwalls, 1,500 feet.

(54) A common feature of the forest floor on exploited sites—an extensive (sometimes 20 to 50 feet square) and deep (6 inches to 4 feet) layer of chips covers the soil. The chips prevent the establishment of weeds, but also of seedling trees. The soil under such chip layers is usually highly acid (pH 4.9–pH 4) owing to the washing out of organic matter in the chips. Chips of Olea yield more acid washings than those of Podocarpus spp.

(55) Subseral communities, exploited forest: Left to right: *Plectranthus fruticosus* (in flower) consocies, forming a dense growth about 8 feet high; *Cluytia pulchella* consocies forming an opener community, 10 feet high. The insolation above the communities (noon, October, 1924) is severe, but the light-intensity *under* the Plectranthus, at ground-level, is 1/450 only; under the Cluytia it is 1/180.—Sourflats Forest, 1,500 feet. (2½ years after removal of top canopy.)

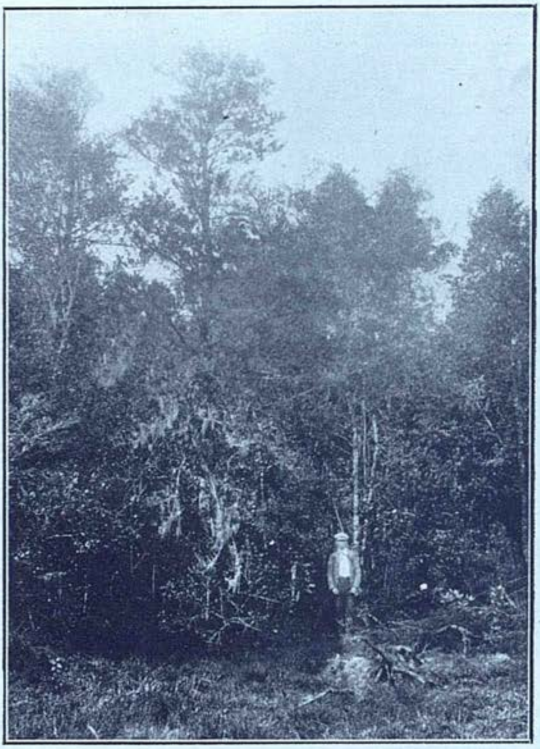
(56) Subseral communities, exploited forest: Left to right: Shoots (coppice) of Halreria lucida and Burchellia capensis 8 to 12 feet high; dense consocies of Plectranthus fruiticosus 9 feet high; tangle of Rubus fruticosus (exotic) on extreme right.—Deepwalls Forest, 1,400 feet. (4 years after removal of top canopy.)

(57) A subseral community of Osteospermum moniliferum appearing on a site from which the top canopy was removed 9 months previous. The plants are 2½ to 4 feet high, and under their cover seedlings of Olea laurifolia and Podocarpus elongata are already appearing.—Harkerville Forest, 700 feet.

(58) Weed-communities on a site from which the canopy was removed 3 years previous. The principal plants (left to right) are Helichrysum petiolatum (white), Mariscus congestus, Plectranthus fruticosus, and Rubus pinnatus; on the extreme right, the fronds of a relict Hemitelia. The weed-growth is 36 inches deep, and is very dense; despite sowings of "seeds" of Curtisia, Olea, Elaeodendron, not a single tree seedling is to be found under the dense cover. The light-intensity at ground-level at noon is 1/800.—Sourflats Forest, 1,600 feet.

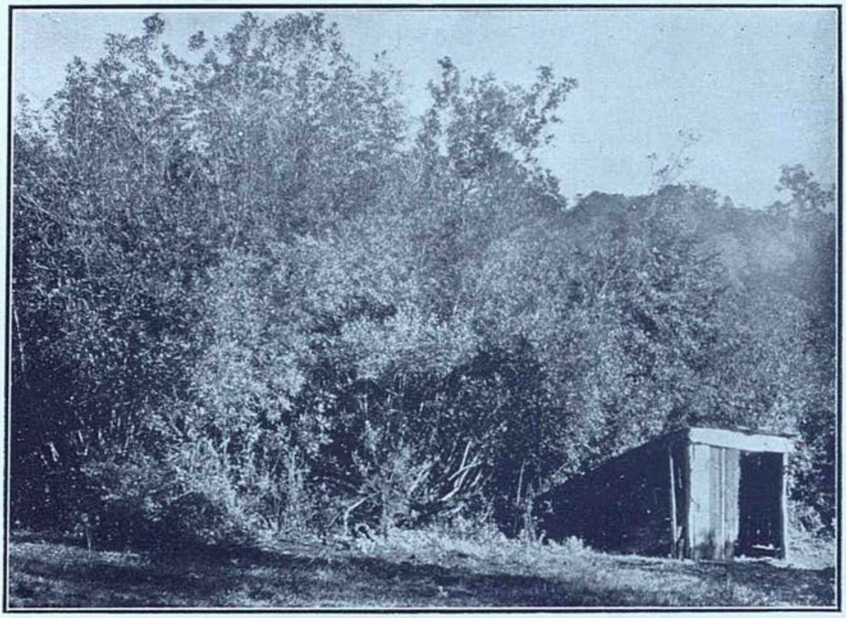
(59) Colonization of a heavily felled site, Climax Forest, by Helichrysum petiolatum (white) and Cluytia affinis—2 years after removal of canopy. Examination of this site (*vide* transect tape) showed that no tree seedlings had appeared, and that those that occurred on the ground prior to removal of the canopy, had been lesioned to death by the severe temperature of the surface soil.—Deepwalls Forest, 1,500 feet.

(60) Moist type forest, Deepwalls, 3 years after heavy felling: In centre, shoots of Halleria lucida 10 feet high; on extreme right, Sparmannia africana 8 feet high; the white weed profusely developed throughout, is the rampant Helichrysum petiolatum. Examination of quadrats on this area showed that no tree seedlings existed; the light-intensity at ground-level ranges from 1/200 to 1/600.

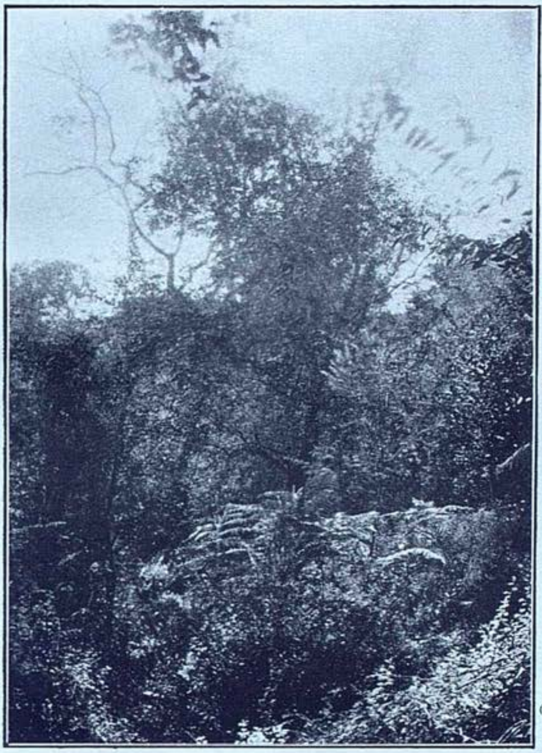


(61) Conversion of forest to bush by means of long-continued exploitation: the Podocarpus Thunbergii seen are 35-40 feet high; the general mass is made up by Myrsine melanophleos, Olea capensis, Pterocelastrus, and Trichocladus crinitus.—Church of England Forest, Harkerville.

(62) Conversion of forest to bush by means of sudden clear felling. The dominants are stunted Podocarpus spp., Peterocelastrus variabilis; shoots of Halleria, Rhamnus, and Burcellia. Helichrysum petiolatum (white) forms extensive and dense communities inhibiting the establishment and development of tree seedlings.—Forest Creek Mining Concession (extent 20 acres)—16 years after felling.



(63) The rôle of coppice—a small Platylophus trifoliatus consocies re-establishing itself by means of coppice, 16 years after clear-felling of the main boles.—The general height of the coppice is 30 feet.—Forest Creek Mining Concession.



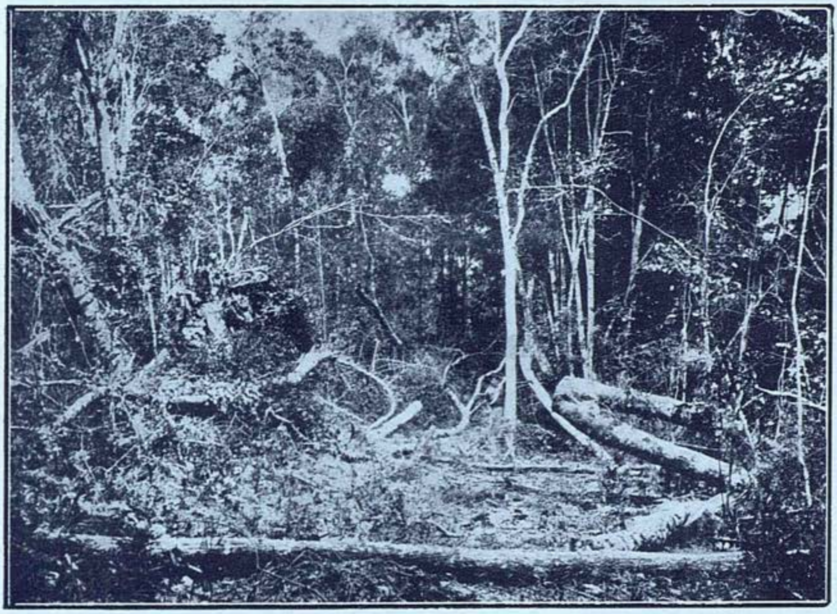
(64) Portion of forest exploited severely and burnt 70 years previous; Halleria lucida, Burchellia capensis, Pteridium aquilinum, and Helichrysum spp. Scattered seedlings and saplings of forest trees appear.

(65) Medium-moist type climax forest, Sourflats, showing a clear-felled strip 22 yards wide, running through it.

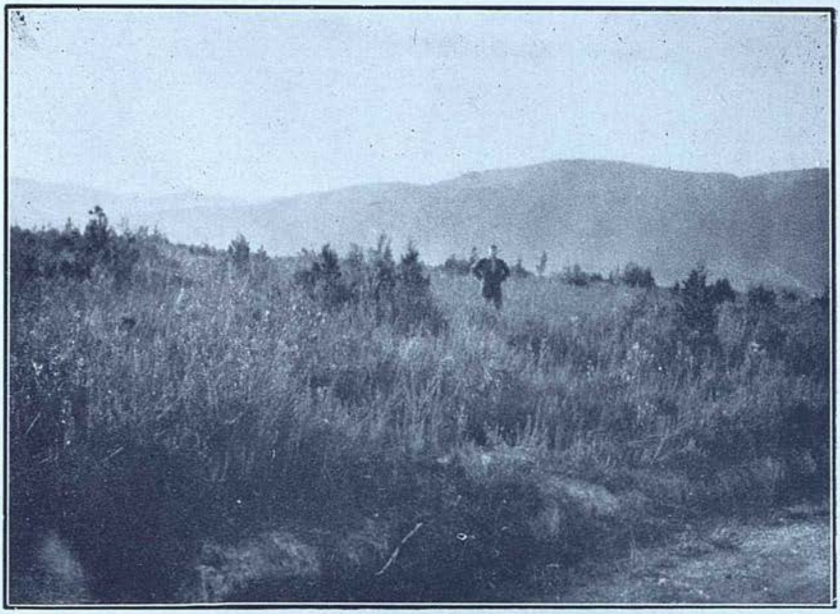
The photograph is instructive in that it contrasts the dark forest on either side of the strip with the brightly illuminated clear-felled strip. Although 2½ years only have elapsed since the removal of the canopy, the felled strip is clad to a height of 4 to 10 feet, with dense Helichrysum petiolatum, Plectranthus fruticosus, Rubus fruticosus, R. pinnatus, and Cluytia spp. Halleria and Burchellia shoots are frequent. Seedlings of tree spp. are almost entirely absent, and quadrate provided with selected "seeds" of forest spp. have produced no plants.

(66) Moist type forest, Deepwalls: Site of a moderate felling. Under canopy, at breast-high, the light-intensity at noon is 1/200–1/100, while under full exposure on the felled site it is 1/2 to 1. The temperature, however, on small felled sites is not a limiting factor. Cluytia spp. and Curtisia faginea seedlings are seen in the right foreground.

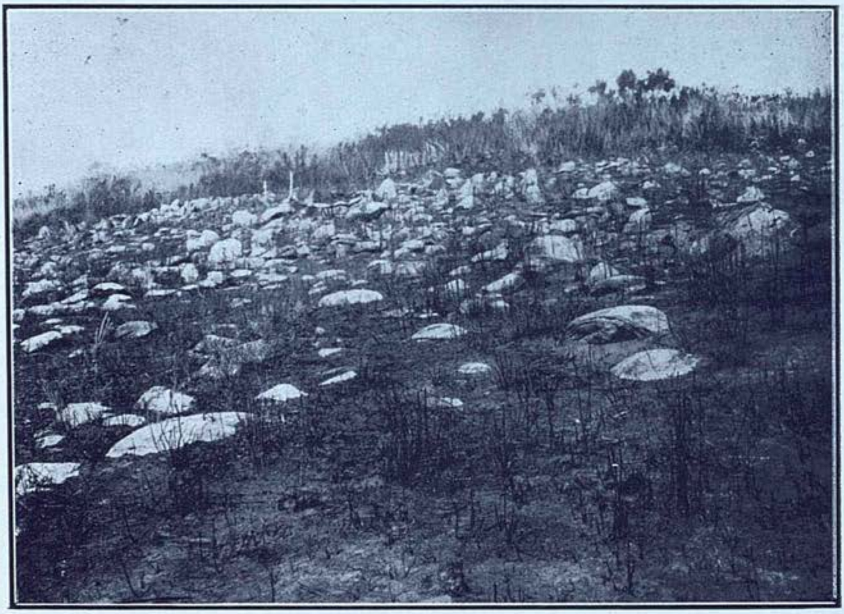
(67) Freshly exploited forest, showing disturbed nature. The canopy was removed just before the taking of the photograph. Stems of Podocarpus Thunbergii, Olea laurifolia, and Apodytes dimidiata are seen from left to right. The insolation at the surface of the soil is severe—numerous lesioned seedlings of Myrsine, Curtisia, Podocarpus spp., and Olea laurifolia were found—January, 1925.—Harkerville Forest.



(68) Freshly exploited forest, showing disturbed nature. Owing to the presence of a stump of Platylophus bearing coppice (on left) this site will, within a few years, be healed. Until such time, the Osteospermum moniliferum seedlings already present (several weeks after felling ceased) will do much to prevent insolation doing damage to any tree seedlings that may appear.

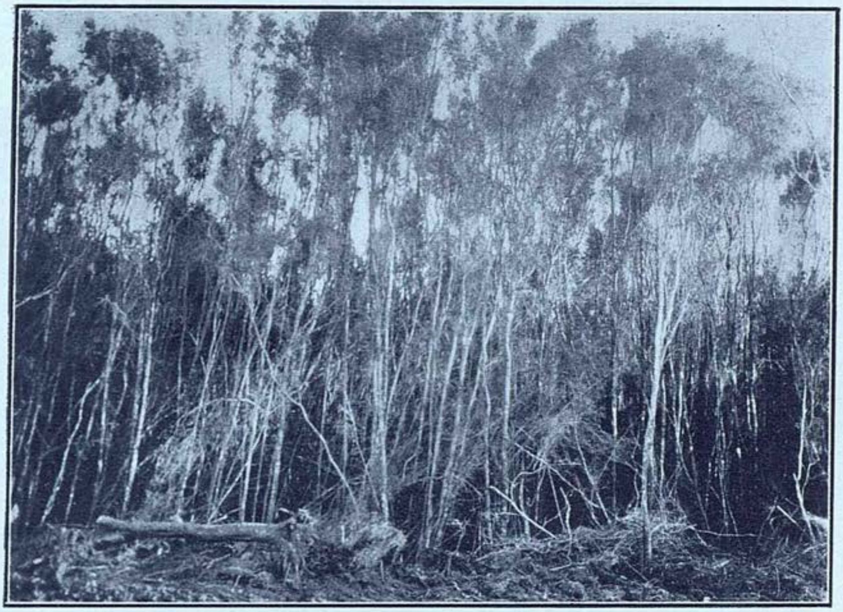


(69) Widdringtonia cupressoides scattered in hygrophilous Macchia. The trees, owing to constantly-recurring fire in the Macchia, are but 5 to 10 feet high.

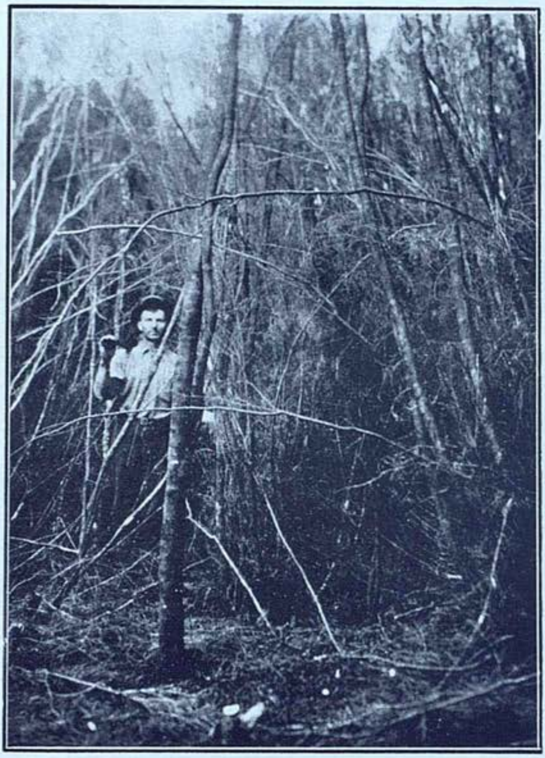


(70) Fired Macchia immediately after the fire. Such sites lose considerable amounts of soil during winds and heavy rains as the surface soil is quite unprotected. The burnt roots of Berzelia, Brunia, Penaea, and Leucadendron seen will all re-shoot.

It was on the site photographed that some of the studies recorded on pp. 21-22, Chapter I, were carried out.—Deepwalls, 1,600 feet.

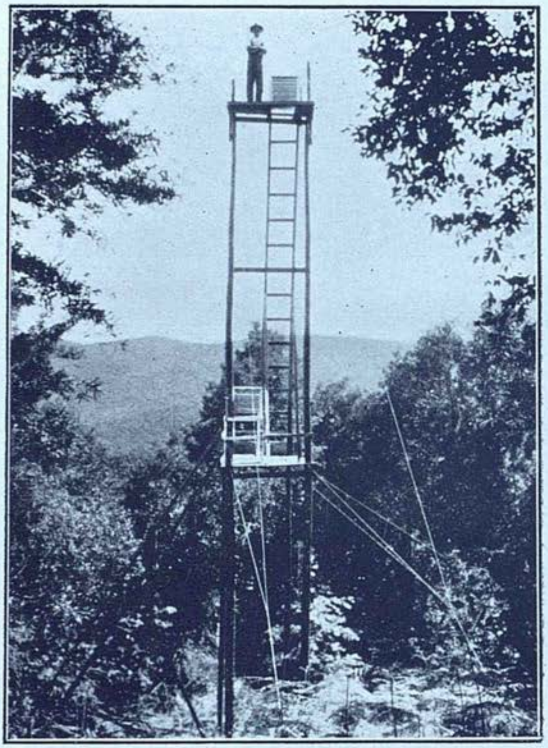


(71) Hygrophilous Macchia that has not been burnt for about 25 years. The principal spp. are Brunia intermedia, Empleurum serrulatum, Erica canaliculata, E. speciosa, Leucadendron eucalyptifolium. Under canopy at ground-level) of the tall shrubs the light-intensity at noon ranges from 1/250 to 1/800; numbers of seedlings of tree spp. (especially of Myrsine, Plectronia spp., Royena spp., Pterocelastrus, Celastrus spp.) are to be found on every square metre, but most of these succumb owing to the dark conditions and the lack of aeration.—De Merk Harkerville, 600 feet.

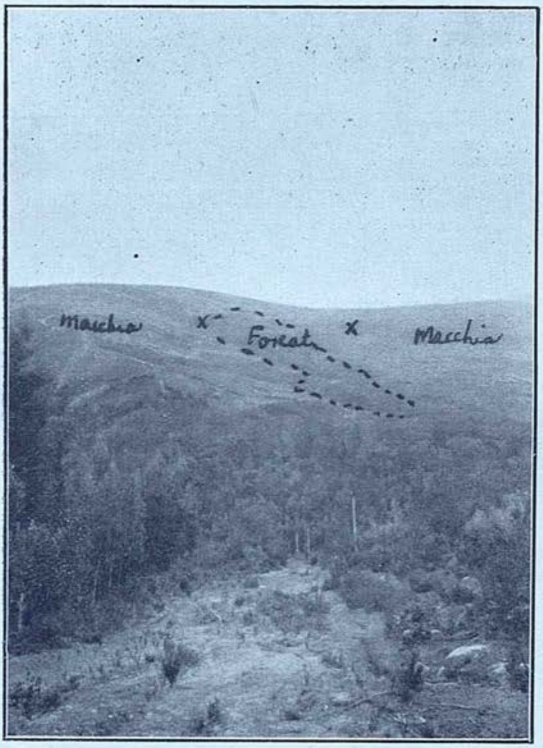


(72) Within the above community: The general height is from 12 to 20 feet; the girths of the larger shrubs range from 5 inches to 12 inches. A clearing was made for purposes of photography.

(73) Dispersal of seed by the Knysna elephant: The large-leafed plants seen are Solanum giganteum, the seeds of which are carried by the elephant. On the death of the animal, the bones of which are seen, the seeds germinated and formed the small Solanum community.—Deepwalls, 1,400 feet.

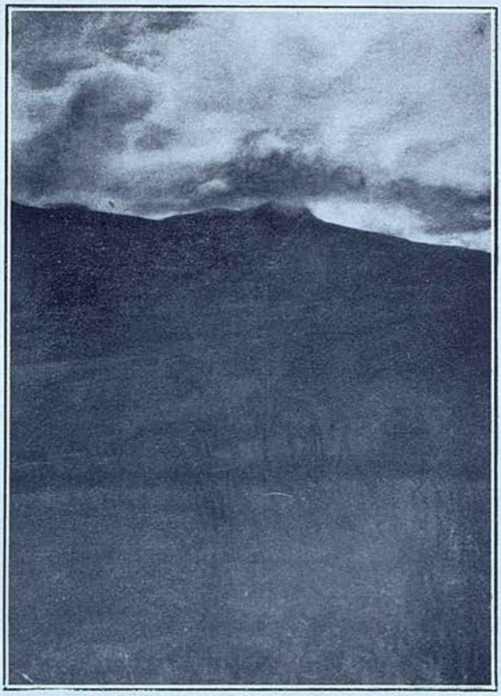


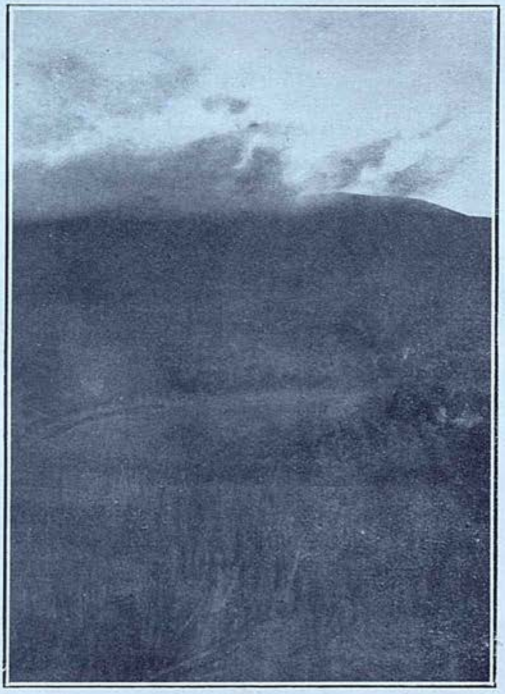
(74) The ladder on the northern aspect, Deepwalls Hill; this ladder is referred to on page 40, Chapter 2, and the data collected from it are summarized in Table VII. A similar structure was used on the southern aspect. The uppermost screen is 40 feet above the ground, the middle one, 20 feet, and the lowest (not seen), 6 inches above the ground.



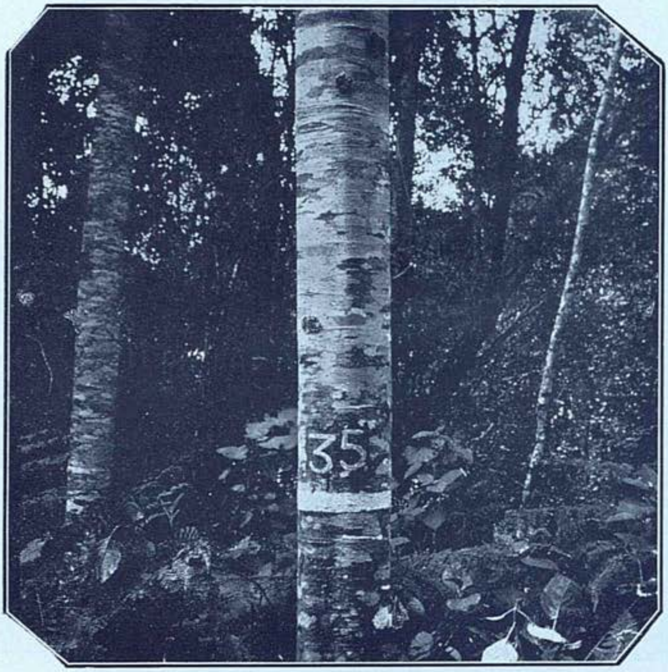
(75) Retreat of the forest before fire; from an examination of the ground it is clear that the relict patch of forest sheltered in the moist valley seen in the centre of the protograph, × at one time was surrounded by forest. The Macchia on all sides of the patch yields direct evidence of being subseral only.—Buffelsnek, 1,700 feet.

(76) A forest relict; 10 years ago this patch was many times larger than shown in the photograph (1923), but constantly occurring fires in the Macchia have accounted for its diminution.—Rondebosch, 1,800 feet.

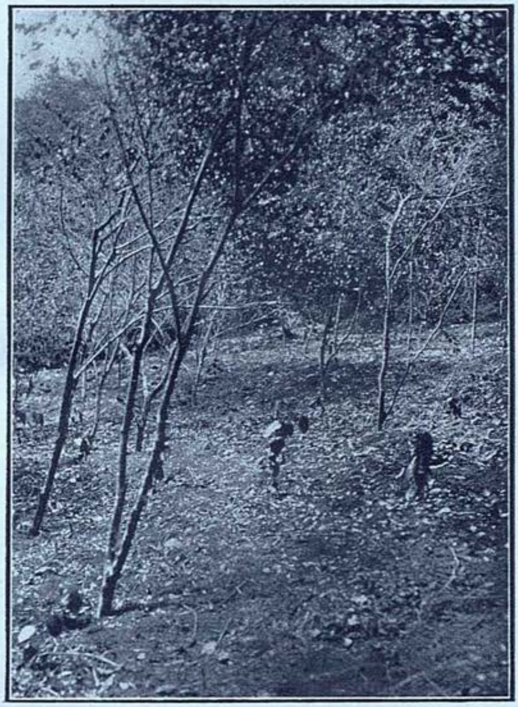




(77), (78) Hydrometeoric Mists or "Nebelreissen" (*vide* Chapter II) on higher sites, Deepwalls. First Dawn. These mists deposit much moisture upon the foliage of the Forest trees and a certain amount upon that of taller Macchia.

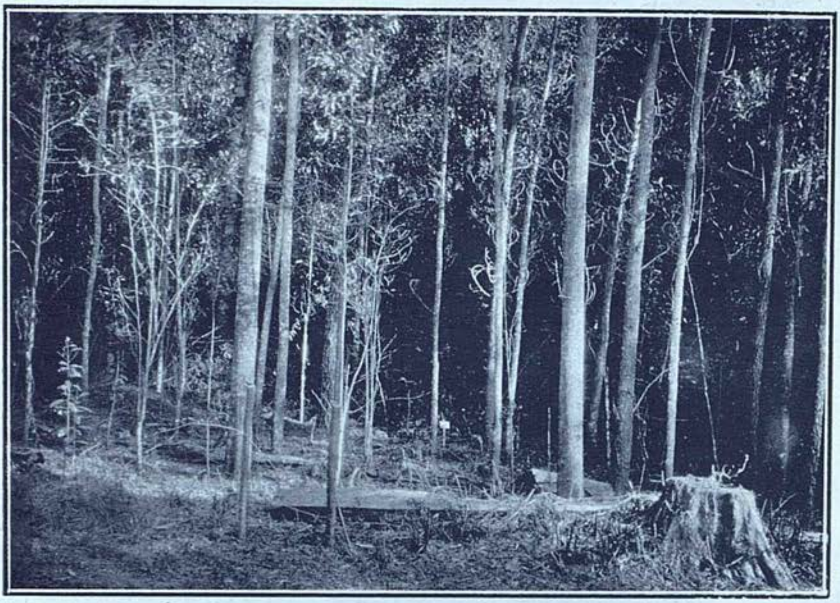


(79) Bole of young Ocotea bullata E. Mey. ("Stinkwood"), showing white band used in study of the girth-increment.

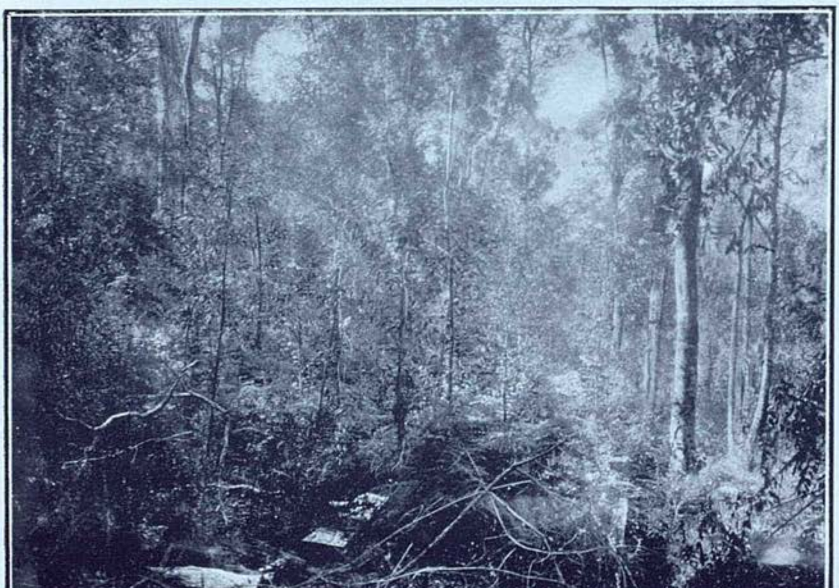


(80) Method of raising insolation-tender seedling trees (Ocotea bullata, Curtisia faginea, Apodytes dimidiata, Platylophus, Cunonia): Branches of shrubs are placed in the ground so as to shield the young trees; the light-intensity is cut down 1/5–1/20, and the soil-temperature at the surface is much decreased.

2-5-
61



(81) Acacia melanoxylon R.Br. (Tasmanian Blackwood) planted in exploited forest, in 1912. 1924: Height 50-60 ft. This sp. reacts strongly on the Holard (*vide* Appendix II).



(82) Acacia melanoxylon R.Br., 2 years old, exploited forest. Such are much sought for food by the elephants. Several in the foreground show broken crowns (*vide* Appendix II).